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THE NEW ORLEANS URBAN FOREST:

STRUCTURE AND MANAGEMENT

THE NEW ORLEANS URBAN FOREST: STRUCTURE AND MANAGEMENT

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Report on the Research Project:

"Influence of Vegetation and Artifical Cover
On Air Temperature And Precipitation Runoff"

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PREFACE

The concept of an urban forest is relatively new to many urban planners and managers. To the general public the term "urban forest" may even sound contradictary. An urban forest, however, is not an oxymoron. An urban forest is an urban ecosystem with its own physical ecology and social ecology. An urban forest is also a biological resource which provides many benefits to urban residents. This report describes the urban forest of New Orleans in its physical, social and institutional context.

Chapter One of the report introduces the problem in the context of earlier research. Chapter Two reports the results of an inventory of the New Orleans urban forest and Chapter Three focuses on the contribution of the forest in New Orleans to air temperature and water run-off, two phenomena thought to be effected by the distribution of urban vegetation. In Chapter Four the urban forest of New Orleans is examined in a broader context; the relationship of urban vegetation to aspects of the physical environment of the city, as well as the social environment, are analyzed using census data and other data especially collected for this study. Finally, Chapter Five describes the institutional actors responsible for managing the New Orleans urban forest, and how the various agencies define their missions and accomplish their goals, along with recommendations for improved coordination and management.

This study was supported by the USDA Forest Service, Northeastern Forest Experiment Station as a portion of a larger research effort to develop a national classification system of urban forests and to understand the impact of urban forests on the character and quality of life in urban areas. The study received its impetus from Dr. Rowan Rowntree of the USDA Forest Service, in Syracuse, New York. Dr. Rowntree and Jack Stevens provided continuing advice during the course of the research. Martha Henderson coordinated data collection, implemented the air temperature and hydrology models, wrote drafts of Chapter 1 and Chapter 3 and assisted with research on other chapters. Michelle Bell, Lance Dunnings and Reginald Ross collected and coordinated data.

Kenneth Cazaubon produced the maps and the graph. John Gubert provided computer assistance. Deborah Barnes and Elaine Borskey provided typing assistance. Many persons provided invaluable information; however, all interpretations and errors are mine. A partial list of those who assisted with information includes Dr. Severn Doughty and Dan Gill from the Louisiana State Cooperative Extension Service; Paul Orr, Louisiana State Urban Forester; Larry Christian and John de Bessonet from the New Orleans Parkway and Parks Commission and Ann Flowers of the Audubon Park Commission.

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EXECUTIVE SUMMARY:

HIGHLIGHTS

The New Orleans urban forest was studied as a part of a larger USDA Forest Service research effort to understand the morphology of the urban forest in cities in various bio-climatic zones in the United States and to understand how urban forests contribute to the quality of life in urban areas. A survey of trees on randomly selected block-faces in the developed portion of Orleans Parish generated a tree data base. A second data base encompassing all land in Orleans Parish was generated from air photos and joined to a census data base at the level of the census tract.

Analysis of the tree survey data revealed:

- The New Orleans urban forest is highly diverse by species, size, form and tree condition.
- The forest is a mature forest, which suggests special management strategies should be developed to protect and replenish this important resource.
- Urban vegetation varies geographically, with the character of the urban forest, differing from one district to another within the city. Management strategies should be sensitive to the geography of the urban forest.
- Tree health in the aggregate is associated with certain aspects of trees' local environment, including the presence of wires, tree crowding, soil and surface cover under tree canopy, land uses near the tree, and public or private management of trees. Tree planting and management strategies should take cognizance of the above factors which impact upon tree health.

Analysis of the second data base indicates:

- The distribution of urban vegetation as measured by tree canopy cover and herbaceous cover, as well as artificial cover and bare soil, indicates that residential and commercial areas in New Orleans are relatively well-stocked with trees. Opportunities for tree stocking exist on institutional land and industrial land, as well as vacant land, parks and land associated with transportation.

- In an attempt to understand how the geography of the urban forest relates to other aspects of the physical environment, it was found that the socio-economic status of neighborhoods, along with the presence of certain land uses, offers the best explanation of the configuration of the urban forest. Thus, the urban forest and its associated climatic, aesthetic, recreational, hydrologic and financial benefits are concentrated in higher socio-economic areas. Lower status neighborhoods are disadvantaged. If equity is a goal, this finding carries implications for planting and management strategies.

Mathematical models of air temperature and storm water run-off were implemented using New Orleans census tract data, assuming various degrees of vegetation cover. The models are not predictive and care should be exercised in their interpretation.

- Since New Orleans is presently well covered with vegetation, adding more vegetation would result in no significant amelioration in the urban heat island effect according to the projections of the air temperature model.

- According to the results of the hydrology model, increasing or decreasing the tree canopy cover would result in modest changes in storm run-off in the developed portion of New Orleans. The hydrology model projects about a six percent increase in run-off volume if all trees are removed and about a five percent decrease in run-off volume if tree canopy coverage is increased to a maximum stocking level.

A survey of the institutional actors in the field of urban forest management in New Orleans suggests the following findings and recommendations.

- A variety of organizations and groups are active in some phase of urban forest management. Serious conflicts between groups are not apparent.

- Although many groups communicate informally, a lack of coordination among the groups exists.

- No single organization or consortium is actively planning urban forest management or even coordinating the various phases of management, from selection and planting, to continued care, to removal and replacement. Each organization is concerned with individual vegetation problems or local issues without examining these problems or issues as a part of a larger urban context. To claim that the organizations "cannot see the forest for the trees" is not hyperbole.

- An organization or consortium should be formed in order to bring about better coordination and comprehensive planning for the continued growth and development of the urban forest in New Orleans.

CHAPTER I

INTRODUCTION

The concept of forestry management in urban landscapes is a relatively recent innovation. Previously, the management of the vegetative structure of a city was largely overlooked by urban planners who preferred to intervene in urban activities such as residential and commerical expansion, transportation development, and the provision of public services. Trees, shrubs and grass were viewed as amentities which could add monetary value to lots in residential areas, beautify commerical zones, and create open spaces for recreational users (Rousakis, 1978). Only recently has the vegetative structure of the United States city received attention as an ecosystem in itself.

For the purposes of this report the urban forest will be defined as: "Vegetation in urban areas acting in conjunction with other natural and cultural components of the ecosystem" (Rowntree and Sanders, 1982). The effects of the urban forest's structure and functions are known to impact the quality of life in urban areas. Further research is needed in order to describe the mechanisms by which urban forests improve and enhance urban environments.

THE DEVELOPMENT OF URBAN FORESTRY RESEARCH

Investigations of the dynamics of the urban forest ecosystem are in preliminary stages. The 1978 National Urban Forestry Conference brought foresters and planners interested in urban forests in the northeastern United States together for the first time. The Conference was sponsored by the USDA Forest Service, and the State University of New York, College of Environmental Science and Forestry. The conference concentrated upon the benefits derived from the management of urban forests. Papers outlining the social benefits derived from urban forests explored the value of greenspace (Driver, Rosenthal and Petersen, 1978), employment created by urban forest management (Collins, 1978), and increasing land values from tree plantings (Bickley, 1978). Environmental benefits were generally discussed in three categories, air quality improvement (McCurdy, 1978; Smith, 1978), water resource management (Corbett, 1978; Lynch 1978; Fusillo, 1978; Sopper and Kerr, 1978; Hartley and Spencer, 1978), and air temperature control (Herrington, 1978). The Conference also included a series of papers describing the wood products produced by urban forests (Geiger, 1978), uses for wastewood

(Loggins, 1978), and mulching from residues (Walker, 1978). Energy conservation and savings were reviewed (Van Heverbeke, 1978). In summary, the 1978 Urban Forest Conference explored the possibilities and benefits of urban forest management.

In 1982 the Second National Urban Forestry Conference was held in Cincinnati co-sponsored by the American Forestry Association, USDA Forest Service, USDA Extension Service, the Ohio Forestry Association, the Cincinnati Park Board and the Ohio Department of Natural Resources. The Conference focused on the successes of urban forestry management in a number of American cities, social and environmental benefits of urban forestry, legal components of urban forestry, its ties with traditional forestry, and methods and training available to communitiies to initiate urban forestry management.

URBAN FORESTRY RESEARCH AND THE USDA FOREST SERVICE

The Forest Service has maintained an active role in urban forestry research through the Northeastern Forest Experiment Station at Syracuse, New York. The Station has been active in evaluating benefits of urban forestry and understanding the dynamics of the urban forest ecosystem. Urban areas seeking assistence in developing urban forest management and planning have received technical support from the station. For example, the City of Dayton, Ohio requested assistance from the Forest Service in evaluating their urban forests for the purposes of modifying the urban microclimate (Rowntree, Sanders and Stevens, 1983). A management system for hillsides was designed to demonstrate how urban vegetation management and urban environment goals and actions intersect in Cincinnati, Ohio (Sanders and Rowntree, 1984). The Forest Service has also evaluated and quantified the structure of the urban forest in Syracuse, New York; Birmingham, Alabama; Modesto, California; Sioux Falls, South Dakota; Eugene, Oregon; Pueblo, Colorado; and Waterbury, Connecticut.

As an example of urban forestry management at the state level, Northeastern Forest Experiment Station personnel (Rowntree and Sanders, 1982) authored a New York State Forest Resources Assessment Report No. 13 entitled The Urban Forest Resource. This 1982 publication describes the concept, history, benefits, and values derived from urban forests. It also calls for urban forest ecosystem management and outlines several management activities for urban areas in the state of New York.

URBAN FORESTRY RESEARCH IN NEW ORLEANS

The City of New Orleans, which is co-terminus with Orleans Parish, was selected by the Forest Service for research because it represents an urban area with a unique history and a significantly different environment than those urban areas already studied. The goals of the research project are to (1) inventory the vegetative structure of New Orleans for the purposes of constructing a national classification system of urban forest structure and (2) to evaluate how different vegetation structures modify urban air temperatures and precipitation runoff for the purposes of estimating their impacts upon census tracts in the New Orleans area. Previous studies of the vegetative structure have been limited to special-purpose inventories of the live oak populations in Audubon Park and City Park. These inventories have been conducted by the Louisiana Department of Natural Resources, Division of Forestry personnel, generally for purposes of tree maintenance.

Earlier descriptions of the New Orleans urban forest have been limited to taxonomic classifications of trees in Louisiana and recent recommendations for urban plantings. Dorman (1941) authored a guide to forest trees in Louisiana which inventoried trees commonly found or trees of commercial value. Written as an educational tool, the book was published by the State Forestry Commission in 1941. An expanded edition appeared in 1945 by Brown (1945) which includes all major forest trees and tree regions of the State, identification and description of species, and information for more advanced forestry students. A relatively recent taxonomy of trees of the South was completed by Dean (1968). Also, general references (Brockman, 1979, for example), can be used. The USFS Southern and Southeastern Forest Experiment Stations' Forest "Atlas of the South" (1969) is a recent taxonomy. The atlas describes the soils, climate, insects, fire occurrence, ownership of forest lands and distribution of tree species from Virginia south to Florida and west to eastern Texas.

Specific to New Orleans, Forrest (1947), published a guide to the trees, vines and shrubs in 1947 which examined 39 species commonly found in the city. A much more recent ratings guide recommending tree species for plantings was compiled by the Metropolitan Area Horticultural Advisory Committee, Louisiana State University Cooperative Extension Service (1983). It was revised in 1985. The companion handbook "Trees for Louisiana Landscapes" (Louisiana Cooperative Extension Service, n.d) describes trees which are recommended for planting and/or found in urban areas of Louisiana. However, no publication or research project has

attempted a comprehensive survey of the New Orleans vegetation. This research project attempts to present and analyze comprehensive data on the structure of the urban forest.

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CHAPTER 2

DESCRIPTION OF THE NEW ORLEANS URBAN FOREST

Research has shown that urban areas function as ecosystems and, therefore, can be described and analyzed using the same methods employed by natural scientists in their analysis of ecosystems (Stearns and Montag 1974). The recognition of urban trees as a part of the urban ecosystem has prompted foresters to describe the characteristics of urban vegetation and to attempt to understand the structure of the urban forest.

Urban forests may be described in terms of measures of vegetation characteristics and spatial relationship among trees, and the biological relationships of trees to other flora and fauna, including humans. The study of urban forest structure often takes the form of a tree inventory. The tree inventory of the New Orleans urban forest is described in this chapter, following a description of the site of New Orleans.

THE SITE OF NEW ORLEANS

The physical geography of the New Orleans site is a product of the Mississippi River and of proximity to Lake Pontchartrain. The site is located on the Southern Mississippi Valley Alluvium Coastal Plain which is composed of unconsolidated sand, silt, clay and small particles with bedrock found at depths below seventy feet (Lewis 1976). The river's deposition and meandering since the Pleistocene is evidenced by the natural levees, low ridges and distributary drainage pattern. Most of the developed portion of New Orleans is below sea level. The oldest parts of the city are built on the natural levee, along the Mississippi river. The backswamp, behind the natural levees, was only developed after the installation of a pumping system beginning in 1899 (Lewis, 1976).

Newton (1972), classifies the natural vegetation of New Orleans' site as cypress forest, bottomland hardwoods (consisting of cottonwoods, sycamore and willow) and marsh. Similarly, Brown (1945), describes the natural vegetation as bottomland hardwoods of cottonwood, sycamore and willow. Prior to settlement the major forest trees of commercial value included oak, gum and cypress. Through time any tree of usable board footage had been cut for building in the city. Sanders and Rowntree (1983) describe the ecoregion as subtropical, characterized by eastern needleleaf and broadleaf forest types.

RESEARCH METHODS

Tree inventory methods usually require the identification of tree species, location of trees, crown dimensions, health, local enviornmental influences on trees and potential stocking levels of trees throughout an area (Grey and Deneke, 1978). While some inventories have focused on street trees (Richards and Stevens, 1978), others have covered all tree canopies observable from aerial photos (Rowntree, 1984).

The New Orleans project includes a structural and locational inventory of trees found along streets in the city. Field data were collected on 310 randomly selected block-faces in the urbanized areas of Orleans Parish. In total, one percent of the parish's block faces were sampled. Computer generated lists of random numbers were used to provide x and y coordinates on a 1:24,000 map of the parish. The block face nearest the generated coordinates was selected for sampling. A toss of a coin selected the side of the street, when necessary. The sample included trees located between the sidewalk and street, or "street trees", trees in front yards within 20 feet of the sidewalk, and, in cases of a median strip in the street (referred to as "neutral ground" in New Orleans), trees on the sampling side of the median strip from a line in the center of the median strip. If trees were located in the center of the median strip, every second tree was included in the sample. Therefore, the transect width of the sample point varied from 35 feet, assuming only front yard and street trees, to 55 feet, including a median strip. The transect length was generally 300 feet, the average length of a city block in New Orleans, but ranged from 32 feet to 1,633 feet.

Since the sample survey of trees in New Orleans is a structural inventory, basic information on tree size, species and location was emphasized in the data collection process. A secondary research objective to examine the relationship between tree condition and health and the urban environment necessitated the collection of additional information.

For each tree in the sampled block-faces, variables include the block location by census tract and district, existing land use, tree species, tree location, diameter of the tree at breast height (DBH), vigor, height, crown dimensions, ground cover under the tree, street surface conditions, drainage, and the presence of wires near the tree. Tree measurements were made using standard tree survey instruments and recorded on a field survey form. Multi-stemmed trees were measured using the International Society of Arboriculture "Guide for Establishing Values of

Trees and Other Plants" (1983). For example, the DBH of a crape myrtle with five stems would be measured by finding the DBH of the largest stem, then averaging the DBH of the remaining stems and adding the two figures together for the DBH of the multi-stemmed tree. Information on tree age was not collected. To a limited extent, size measures are used as a surrogate for age in the analysis that follows.

TREE INVENTORY

A total of 1388 trees are included in the survey. The largest number are located on the public strip or parkstrip, the strip of land between sidewalk and street (Table 2.1). A much smaller number are located on median strips in the middle of streets. Both of these groups can be classified as public trees. Four hundred sixty-one trees (461) are located on land within 20 feet of the sidewalk, which is presumed to be private land. (The assumption that the public right-of-way ends with the sidewalk may not be correct in all cases, but in New Orleans the sidewalk constitutes the effective boundary between publicly-managed trees and privately managed trees. Publicly-managed trees in New Orleans are the responsibility of the Parkway and Parks Commission.)

An insignificant number of trees (only 5), are located within 20 feet of the sidewalk (or street if no sidewalk is present), on land which is public park or open space. Discounting these five trees and the presumed 461 other trees, 922 trees are located on public land. Since the sample includes about one percent of the block faces in New Orleans, 92,200 trees is a good conservative estimate of the public trees found on median strips and parkstrips in Orleans Parish. Not included in this estimate are the trees in city parks and publically-owned undeveloped land in New Orleans East or Lower Algiers. A true estimate of all public trees in New Orleans would need to include an inventory of trees in City Park, Audubon Park and other smaller parks and squares. Hence, 92,200 trees is an estimate of only a portion of the publicly-owned and publicly-managed trees in the City of New Orleans.

Tree Species and Form

The urban forest is a mixed and diverse forest; sixty-one species are identified in the survey. (See Table 2.2 for a list of species using common names and the Appendix for common names and scientific names.) Only five species account for more than five percent each of the forest: Live Oak, Crape Myrtle, Slash Pine, Loblolly Pine, and Southern

Figure 2.1: Live Oak Trees with hanging Spanish Moss in City Park.

Figure 2.2: Pines along a street in a residential land-use zone.

TABLE 2.1

NUMBER OF TREES BY LOCATION

Location	Number	Percent
Public strip (parkstrip)	823	59.3
Median strip	99	7.1
Private land (Twenty feet from sidewalk	461	33.2
Parks and open space (Twenty-feet from street or sidewalk)	5	.4
Total	1,388	100.0
Publicly-managed*	922	66.7
Privately-managed	461	33.3
Total	1,383	100.0

*Includes trees growing on public strip and median strip, but not trees on parkland and open space.

Source: Tree Survey

TABLE 2.2

TREE SPECIES BY LOCATION

Species	Publicly-managed Trees		Privately-managed Trees		All Trees	
	Number	Percent	Number	Percent	Number	Percent
Ailanthus	2	.2	2	.4	4	.3
Arizona Ash	3	.3	2	.4	5	.4
Green Ash	2	.2	0	.0	2	.1
White Leaf Ash	1	.1	0	.0	1	.1
Red Bay	0	.0	1	.2	1	.1
River Birch	5	.5	3	.7	8	.6
Boxelder	1	.1	0	.0	1	.1
Red Bud	2	.2	0	.0	2	.1
Camphor-tree	1	.1	0	.0	1	.1
Southern Catalpa	5	.5	3	.7	8	.6
Black Cherry	2	.2	0	.0	2	.1
Cherry Laurel	5	.5	6	1.3	11	.8
Chinaberry	3	.3	5	1.1	8	.6
Coffee Tree	1	.1	0	.0	1	.1
Eastern Cottonwood	20	2.2	12	2.6	32	2.3
Crape Myrtle	225	24.4	39	8.5	264	19.0
Bald Cypress	5	.5	7	1.5	12	.9
Pine Cypress	2	.2	0	.0	2	.1
Dogwood	1	.1	1	.2	2	.1
American Elder	0	.0	1	.2	1	.1
American Elm	13	1.4	11	2.4	25	1.8
Small Leaf Elm (Chinese Elm)	29	3.1	14	3.0	43	3.1
Gingko	1	.1	0	.0	1	.1
Golden Rain Tree	39	4.2	13	2.8	54	3.9
Hackberry (Sugarberry)	21	2.3	16	3.5	37	2.7
Hercules Club	5	.5	0	0	5	.4
American Holly	7	.8	1	.2	8	.6
Possumhaw Holly	0	.0	1	.2	1	.1
Hornbean	14	1.5	3	.7	17	1.2
Pyramid Magnolia	1	.1	2	.4	3	.2
Southern Magnolia	31	3.4	42	9.1	73	5.3
Sweetbay Magnolia	5	.5	1	.2	6	.4
Red Maple	9	1.0	9	2.0	18	1.3
Silver Maple	8	.9	0	.0	8	.6
Sugar Maple	8	.9	1	.2	9	.6
Mimosa	2	.2	9	2.0	9	.6
Blue Jack Oak	3	.3	0	.0	3	.2
Laurel Oak	38	4.1	14	3.0	52	3.7
Live Oak	203	22.0	110	23.9	315	22.7

TABLE 2.2 (Continued)

TREE SPECIES BY LOCATION

Species	Publicly-managed Trees		Privately-managed Trees		All Trees	
	Number	Percent	Number	Percent	Number	Percent
Cherrybark Oak	2	.2	0	.0	2	.1
Overcup Oak	1	.1	0	.0	1	.1
Water Oak	33	3.6	12	2.6	45	3.2
White Oak	1	.1	0	.0	1	.1
Willow Oak	1	.1	2	.4	3	.2
Parkinsonia (Jerusalem-Thorn)	0	.0	1	.2	1	.1
Pecan	5	.5	16	3.5	21	1.5
Persimmon	1	.1	3	.7	4	.3
Podocarp	1	.1	2	.4	3	.2
Cabbage Palmetto Palm	7	.8	0	.0	7	.5
Texas Palmetto	1	.1	0	.0	1	.1
Loblolly Pine	34	3.7	58	12.6	92	6.6
Slash Pine	71	7.7	23	5.0	94	6.8
Spruce Pine	3	.3	0	.0	3	.2
Silverbell	0	.0	1	.2	1	.1
Sweetgum	12	1.3	4	.9	16	1.2
Sycamore	13	1.4	4	.9	17	1.2
Tulip Popular	2	.2	2	.4	4	.3
Tung Oil	2	.2	1	.2	3	.2
Black Willow	1	.1	0	.0	1	.1
Weeping Willow	3	.3	1	.2	4	.3
Washingtonia Palm	5	.5	2	.4	7	.5

Source: Tree Survey

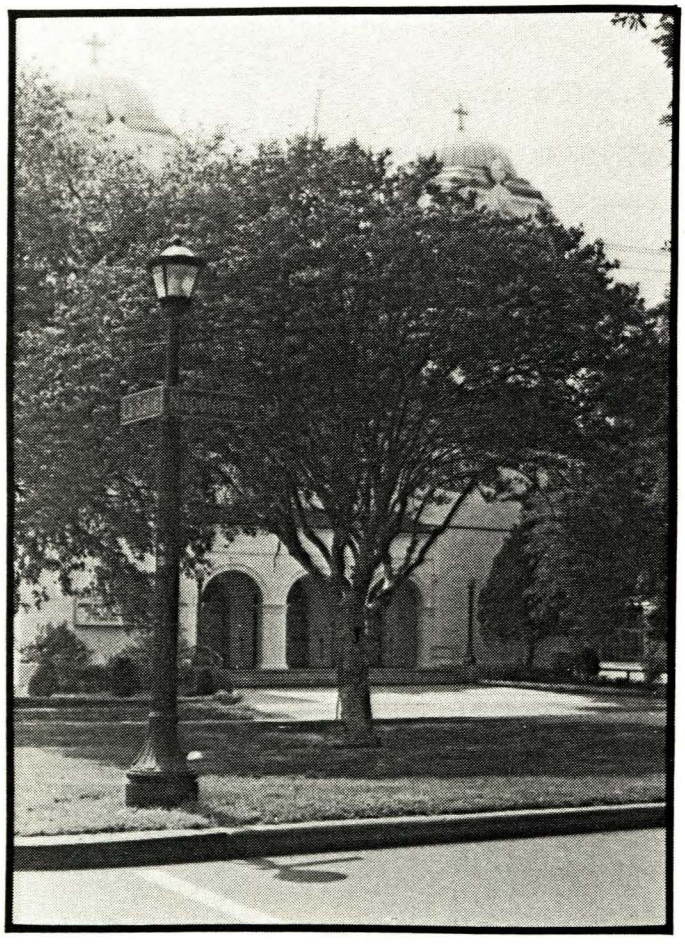

Figure 2.3:
Flowering Crape Myrtle
on a "neutral-ground"
of Napoleon Avenue.

Figure 2.4:
Southern Magnolia
in single-family
residential
land-use zone.

Magnolia. Together the five species account for 60.4 percent of all trees surveyed. Among public trees Crape Myrtle, Live Oak, and Slash Pine each accounts for five percent or more; 54.1 percent together. Among private trees Live Oak, Loblolly Pine, Southern Magnolia, and Crape Myrtle each accounts for five percent or more of all trees; 54.1 percent together. Surprisingly, the private urban forest does not appear to be significantly more diverse than the public forest.

Species found in the New Orleans urban forest differ in form (Table 2.3). Most trees are single-stem (N=1203, 90 percent). Much smaller numbers are multi-stem (N=68, 5.1 percent) and forked below 5 feet (N=66, 4.9 percent). Species that often assume complex forms include Crape Myrtle and Golden Rain Tree. Other species tend to be single stemmed or they are represented in small numbers.

Tree Size

Tree species differ substantially with regard to several measures of size. The mean dbh (diameter breast height) of all trees is 13.49 inches (Table 2.4). The mean dbh of Golden Rain Tree, Hackberry, and Live Oak exceeds 18 inches with large standard deviations, indicating a range of sizes. Cherrybark Oak, Black Willow, Arizona Ash and White Ash also exhibit large mean dbh's, but these species are represented by small numbers of trees, making generalization difficult. Among the five dominant species (Live Oak, Crape Myrtle, Slash Pine, Loblolly Pine, and Southern Magnolia) the Live Oak trees account for the largest number of trees having dbh's of 20 inches or more. (See Figure 2.5.) Much smaller numbers of mature trees with dbh's of 20 inches or greater are found among the sample of Crape Myrtle, Slash Pine and Southern Magnolia. The sample of Crape Myrtle and Slash Pine is dominated by trees having dbh's under 10 inches.

The mean height of all trees is 34.03 feet (Table 2.5). The mean height of the River Birch, Chinaberry, Live Oak, Pecan, Loblolly Pine, Sycamore, Laurel Oak, and Arizona Ash is over 40 feet. The mean height of the Cherrybark Oak is a staggering 65 feet (standard deviation only 4.24 feet), but only two are represented in the sample. The mean height of the Crape Myrtle (21.21 feet, standard deviation 6.13 feet) is modest, probably indicative of recent planting and a small mature size. Red Maples (N=18) are also of modest mean height (21.5 feet). Other trees of modest height which are not numerous include Ginkgo, Persimmon, Ailanthus, Coffee Tree, Tung Oil, Pine Cypress, Possumhaw Holly,

TABLE 2.3

TREE SPECIES BY FORM

Species	Single Stem		Multi-Stem		Forked Below 5 Feet	
	Number	Percent	Number	Percent	Number	Percent
Ailanthus	3	75	0	0	1	25
Arizona Ash	5	100	0	0	0	0
Green Ash	1	50	0	0	1	50
White Ash	1	100	0	0	0	0
Red Bay	1	100	0	0	0	0
River Birch	8	100	0	0	0	0
Boxelder	1	100	0	0	0	0
Red Bud	2	100	0	0	0	0
Camphor-tree	0	0	0	0	1	100
Southern Catalpa	4	50	1	12.5	3	37.5
Black Cherry	1	50	1	50	0	0
Cherry Laurel	10	90.9	0	0	1	9.1
Tallow	2	40	2	40	1	20
Coffee Tree	1	100	0	0	0	0
Eastern Cottonwood	27	90	0	0	3	10
Crape Myrtle	190	72.8	43	16.5	28	10.7
Bald Cypress	12	100	0	0	0	0
Pine Cypress	1	50	0	0	1	50
Dogwood	1	50	0	0	1	50
American Elder	1	100	0	0	0	0
American Elm	23	95.8	0	0	1	4.2
Small Leaf Elm (Chinese Elm)	40	95.2	1	2.4	1	2.4
Gingko	1	100	0	0	0	0
Golden Rain Tree	17	65.4	7	26.9	2	7.7
Hackberry (Sugarberry)	30	93.8	1	3.1	1	3.1
Hercules Club	4	80	0	0	1	20
American Holly	8	100	0	0	0	0
Possumhaw Holly	1	100	0	0	0	0
Hornbean	17	100	0	0	0	0
Pyramid Magnolia	1	33.3	1	33.3	1	33.3
Southern Magnolia	69	94.5	1	1.4	3	4.1
Sweetbay Magnolia	6	100	0	0	0	0
Red Maple	18	100	0	0	0	0
Silver Maple	7	87.5	0	0	1	12.5
Sugar Maple	8	88.9	1	11.1	0	0
Mimosa	5	50	4	40	1	10
Blue Jack Oak	3	100	0	0	0	0
Laurel Oak	52	100	0	0	0	0
Live Oak	305	96.8	4	1.3	6	1.9

TABLE 2.3 (Continued)

TREE SPECIES BY FORM

Species	Single Stem		Multi-Stem		Forked Below 5 Feet	
	Number	Percent	Number	Percent	Number	Percent
Cherrybark Oak	2	100	0	0	0	0
Overcup Oak	1	100	0	0	0	0
Water Oak	1	100	0	0	0	0
White Oak						
Willow Oak	3	100	0	0	0	0
Parkinsonia (Jerusalem Thorn)	1	100	0	0	0	0
Pecan	18	90	1	5	1	5
Persimmon	3	75	0	0	1	25
Podocarp	2	66.7	0	0	1	33.5
Cabbage-Palmetto Palm	7	100	0	0	0	0
Loblolly Pine	92	100	0	0	0	0
Slash Pine	92	97.9	0	0	2	2.1
Spruce Pine	3	100	0	0	0	0
Silverbell	1	100	0	0	0	0
Sweetgum	15	93.8	0	0	1	6.3
Sycamore	16	94.1	0	0	1	5.9
Tulip Poplar	4	100	0	0	0	0
Tung Oil	3	100	0	0	0	0
Black Willow	1	100	0	0	0	0
Weeping Willow	4	100	0	0	0	0
Washington Palm	2	100	0	0	0	0

Note: Data not collected for trees classified as dead, declining.

Source: Tree Survey

TABLE 2.4

DIAMETER BREAST HEIGHT (DBH) IN INCHES BY SPECIES

Species	Mean	Standard Deviation	Number
Ailanthus	6.25	2.21	4
Arizona Ash	22.00	9.30	5
Green Ash	11.50	6.36	2
White Ash	18.00	.00	1
Red Bay	15.00	.00	1
River Birch	15.37	6.45	8
Boxelder	3.00	.00	1
Red Bud	8.95	9.97	2
Camphor-tree	6.00	.00	1
Southern Catalpa	10.37	6.02	8
Black Cherry	12.50	9.19	2
Cherry Laurel	9.27	5.69	11
Chinaberry	17.25	3.53	8
Coffee Tree	13.00	.00	1
Eastern Cottonwood	11.21	6.52	32
Crape Myrtle	9.18	4.71	264
Bald Cypress	9.66	6.05	12
Pine Cypress	5.00	2.82	2
Dogwood	12.00	8.48	2
American Elder	6.00	.00	1
American Elm	15.40	7.72	25
Small Leaf Elm (Chinese Elm)	10.32	4.86	43
Gingko	4.00	.00	1
Golden Rain Tree	19.01	9.69	54
Hackberry (Sugarberry)	19.72	9.72	37
Hercules Club	6.80	2.16	5
American Holly	4.50	.92	8
Possumhaw Holly	5.00	.00	1
Hornbean	12.23	3.61	17
Pyramid Magnolia	13.00	2.64	3
Southern Magnolia	10.83	6.51	73
Sweetbay Magnolia	10.66	3.26	6
Red Maple	5.38	2.54	18
Silver Maple	16.25	8.87	8
Sugar Maple	12.11	4.96	9
Mimosa	11.45	3.85	11
Blue Jack Oak	10.33	.57	3
Laurel Oak	17.89	8.07	52
Live Oak	19.57	11.49	315

TABLE 2.4 (Continued)

DIAMETER BREAST HEIGHT (DBH) IN INCHES BY SPECIES

Species	Mean	Standard Deviation	Number
Cherrybark Oak	20.50	4.94	2
Overcup Oak	4.00	.00	1
Water Oak	8.36	7.65	45
White Oak	8.00	.00	1
Willow Oak	14.33	7.23	3
Parkinsonia (Jerusalem Thorn)	5.00	.00	1
Pecan	14.76	7.16	21
Persimmon	8.25	3.50	4
Podocarp	16.66	3.05	3
Cabbage-Palmetto Palm	14.28	2.75	7
Texas Palmetto	15.00	.00	1
Loblolly Pine	11.73	3.60	92
Slash Pine	9.33	4.27	94
Spruce Pine	4.66	.57	3
Silverbell	13.00	.00	1
Sweetgum	13.93	5.02	16
Sycamore	16.35	10.72	17
Tulip Poplar	11.50	8.81	4
Tung Oil	8.33	2.08	3
Black Willow	28.00	.00	1
Weeping Willow	13.50	2.38	4
Washington Palm	15.71	7.11	7
All Trees	13.49	8.85	1388

Source: Tree Survey

TABLE 2.5

TOTAL HEIGHT IN FEET BY SPECIES

Species	Mean	Standard Deviation	Number
Ailanthus	23.75	3.30	4
Arizona Ash	50.80	13.77	5
Green Ash	26.50	2.12	2
White Ash	50.00	.00	1
Red Bay	34.00	.00	1
River Birch	71.87	14.21	8
BoxElder	27.00	.00	1
Red Bud	48.00	8.48	2
Camphor-tree	19.00	.00	1
Southern Catalpa	27.62	7.44	8
Black Cherry	37.00	21.21	2
Cherry Laurel	28.54	7.00	11
Chinaberry	40.80	8.25	5
Coffee Tree	15.00	.00	1
Eastern Cottonwood	29.40	12.97	30
Crape Myrtle	21.21	6.13	261
Bald Cypress	28.25	11.52	12
Pine Cypress	13.00	2.82	2
DogWood	34.50	19.09	2
American Elder	22.00	.00	1
American Elm	37.29	13.88	24
Small Leaf Elm, (Chinese Elm)	30.78	12.30	42
Ginkgo	25.00	.00	1
Golden Rain Tree	40.34	6.31	26
Hackberry, Sugarberry	46.62	15.17	32
Hercules Club	26.40	4.92	5
American Holly	17.25	1.28	8
Possumhaw Holly	16.00	.00	1
HornBeam	40.58	13.14	17
Pyramid Magnolia	21.33	6.65	3
Southern Magnolia	29.95	11.67	73
Sweetbay Magnolia	28.83	10.16	6
Red Maple	21.50	8.11	18
Silver Maple	38.50	12.66	8
Sugar Maple	36.66	11.88	9
Mimosa	23.40	6.07	10
Blue Jack Oak	27.33	2.30	3
Laurel Oak	46.63	19.91	52
Live Oak	41.70	17.89	315

TABLE 2.5 (Continued)

TOTAL HEIGHT IN FEET BY SPECIES

Species	Mean	Standard Deviation	Number
Cherrybark Oak	65.00	4.24	2
Overcup Oak	16.00	.00	1
Water Oak	31.00	24.17	45
White Oak	37.00	.00	1
Willow Oak	34.66	17.21	3
Parkinsonia, (Jerusalem Thorn)	34.00	.00	1
Pecan	49.55	18.41	20
Persommin, Plum	22.50	9.46	4
Podocarp	27.33	5.77	3
Cabbage-Palmetto Palm	22.28	10.51	7
Loblolly Pine	40.15	13.88	92
Slash Pine	31.94	21.17	94
Spruce Pine	12.00	2.64	3
SilverBell	35.00	.00	1
SweetGum	40.87	14.47	16
Sycamore	50.00	22.27	17
Tulip Poplar	36.50	24.28	4
Tung Oil	21.00	3.00	3
Black Willow	40.00	.00	1
Weeping Willow	37.75	6.18	4
Washingtonia Palm	34.50	33.23	2
All Trees	34.02	17.24	1337

Note: Data not collected for trees classified as dead, declining.

Source: Tree Survey

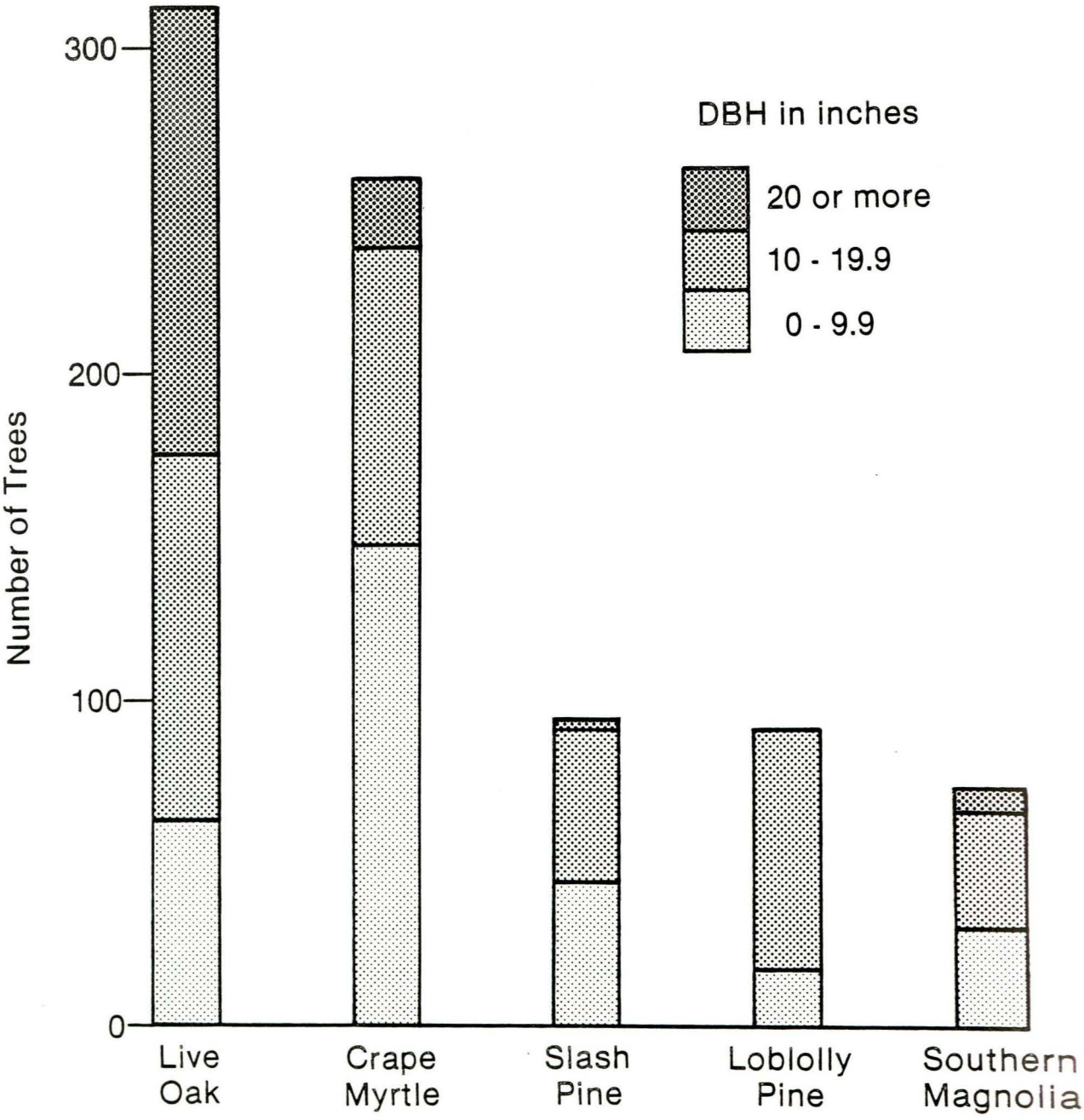

Figure 2.5:
DBH (Diameter Breast Height) of Dominant Species in inches.

Pyramid Magnolia, Cabbage Palmetto Palm, Overcup Oak and American Elder.

The height of the base to the crown of the trees parallels the total height (Table 2.6). Tree species with a large mean height also tend to have a large base to crown height, including the River Birch, Black Cherry, Chinaberry, American Elm, Live Oak, Cherrybark Oak, Pecan, Loblolly Pine, Slash Pine, Silverbell, Sycamore, Tulip Popular, Balck Willow, Laurel Oak, Arizona Ash, Coffee Tree, Podocarp, Red Bud and American Elder. Also, the relatively large mean base to crown height of the Washintonia Palm (23.00 feet) is related to its form.

Overall, the data on dbh, total height and the height of the base to crown the describe an urban forest with a large biomass and relatively large individual trees. If all trees are ranked by total height, the tenth (10th) percentile is an impressive 15 feet tall. The nintieth (90th) percentile is 56 feet tall and the tallest tree sampled is 145 feet tall. The largest dbh is a massive 53 inches.

Similarly, the crowns of the sampled trees are quite large. Tree crowns in U.S. Forest Service studies have been measured by the crown's dimension parallel to the street and the crown's dimension perpendicular to the street. For the sample, the mean parallel to street and perpendicular to street dimensions are the same, 24.36 feet. The standard deviation for parallel to street is 14.81 feet and for perpendicular to street 14.92 feet. The range of crown sizes perpendicular to the street is 3 feet to 151 feet feet. Some tree crowns, especially those of mature Live Oaks, extend over the street and even over private land on the other side of the street. In conclusion, the data on tree size creates a picture of a mature urban forest with some younger smaller trees.

TREE CONDITION

In order to ascertain the health of the New Orleans urban forest all trees included in the sample tree inventory were classified according to their general condition. The research objective is to understand factors related to tree condition. While the condition and health of each individual tree depends upon species characteristics and tolerances, along with immediate environmental conditons, the object is to identify environmental correlates of tree condition in the aggregate. If such environmental correlates can be determined, along with the nature of their effect on tree condition in the aggregate, appropriate

TABLE 2.6

BASE TO CROWN HEIGHT IN FEET BY SPECIES

Species	Mean	Standard Deviation	Number
Ailanthus	8.75	2.50	4
Arizona Ash	16.20	4.60	5
Green Ash	9.50	2.12	2
White Ash	9.00	.00	1
Red Bay	8.00	.00	1
River Birch	13.12	8.40	8
BoxElder	6.00	.00	1
Red Bud	12.00	5.65	2
Camphor-Tree	8.00	.00	1
Southern Catalpa	8.37	4.13	8
Black Cherry	13.00	9.89	2
Cherry Laurel	9.00	2.64	11
Chinaberry	10.80	1.78	5
Coffee Tree	10.00	.00	1
Eastern Cottonwood	7.70	3.25	30
Crape Myrtle	7.98	2.24	261
Bald Cypress	5.66	2.96	12
Pine Cypress	6.00	.00	2
Dogwood	9.00	2.82	2
American Elder	10.00	.00	1
American Elm	10.08	3.93	24
Small Leaf Elm, (Chinese Elm)	8.71	3.53	42
Ginkgo	6.00	.00	1
Golden Rain Tree	9.61	1.89	26
Hackberry, Sugarberry	10.50	3.49	32
Hercules Club	7.00	.70	5
American Holly	5.37	.51	8
Possumhaw Holly	5.00	.00	1
HornBeam	9.82	2.37	17
Pyramid Magnolia	5.00	1.00	3
Southern Magnolia	8.17	7.18	73
Sweetbay Magnolia	7.50	3.50	6
Red Maple	6.50	3.24	18
Silver Maple	8.87	2.69	8
Sugar Maple	8.22	1.39	9
Mimosa	8.30	2.66	10
Blue Jack Oak	8.66	.57	3
Laurel Oak	14.73	6.02	52
Live Oak	13.69	6.60	315

TABLE 2.6(Continued)

BASE TO CROWN HEIGHT IN FEET BY SPECIES

Species	Mean	Standard Deviation	Number
Cherrybark Oak	10.00	1.41	2
Overcup Oak	4.00	.00	1
Water Oak	7.84	3.49	45
White Oak	9.00	.00	1
Willow Oak	8.66	4.16	3
Parkinsonia, Jerusalem Thorn	7.00	.00	1
Pecan	12.60	5.50	20
Persommin, Plum	8.75	3.30	4
Podocarp	11.33	10.11	3
Cabbage-Palmetto Palm	14.57	4.82	7
Loblolly Pine	13.64	5.83	92
Slash Pine	10.51	5.56	94
Spruce Pine	5.66	.57	3
Silverbell	18.00	.00	1
SweetGum	9.25	5.10	16
Sycamore	13.05	8.11	17
Tulip Poplar	10.00	7.87	4
Tung Oil	7.33	.57	3
Black Willow	10.00	.00	1
Weeping Willow	7.75	.95	4
Washingtonia Palm	23.00	24.04	2
All Trees	10.59	5.72	1337

Note: Data Collected for trees classified as dead declining.

Source: Tree Survey

strategies for urban forest management in New Orleans can be designed. Data were collected on land cover under tree crowns, tree crowding, tree location with respect to land uses, tree location with respect to the street and management responsibilities, and the presence of wires.

The condition of each tree surveyed was determined by visible characteristics. Tree health was determined by crown development, foilage density, size and color; the presence of insects and disease; trunk condition and damage; exposure or injury of roots; the dropping of twigs and the presence of dead wood. Also, the presence of significant new growth was another dimension of tree condition. A judgement of tree condition may also include other factors such as crown configuration, the presence of overhead wires or underground utility lines, pruning, soil type and soil acidity, grade, and drainage (Council of Tree and Landscape Appraisers, 1983). However, some of these factors are incorporated in other variables and other factors are not relevant to the research objectives or are not readily observable. Tree condition is inherently a multi-attribute characteristic. Therefore, in the absence of a mathematical procedure the determination of tree condition will remain a judgemental issue. The scheme for judging tree condition used here is easily taught and relatively easy to apply because it depends solely upon visible evidence. It also has the virtue of being conceptually distinct from certain environmental factors that may contribute to tree condition; thus, allowing for the investigation of correlates and their presumed effects.

Each tree was assigned to one of five condition categories: "Vigorous, good," "vigorous, poor," "stable, good," "stable, poor" and "declining, dead." The model value (N=747) for all trees in New Orleans is "stable, good," indicating a tree in basically healthy condition, but exhibiting little or no recent growth. The second largest number of trees (N=475) can be classified as "Vigorous, good," or trees in excellent health with significant growth. Smaller numbers of trees are classified as "Stable, poor" (N=88) and "Vigorous, poor" (N=25). "Vigorous, poor" is a problematic category because it descibes a tree with recent growth but in poor condition. Perhaps this accounts for the small number of trees in that category. Only 53 trees in the sample, or 3.8 percent, are classified as declining or dead.

An examination of tree condition for each tree species reveals wide disparities in vigor (Table 2.7). Discounting species with fewer than 10 trees in the sample, species can be classified into 3 groups according to the percentage of the species in each vigor category, especially the modal

category for each species (i.e. the vigor category with the largest number of trees for each species). The first and largest group are species having the largest number of trees in the "Stable, good" category. These species may also have some trees in healthier categories or less-healthy categories, as well. These Type I species include Crape Myrtle, Southern Magnolia, Live Oak, Loblolly Pine, and Slash Pine. These species are also the dominant species and among the largest species by size in the New Orleans urban forest. Other Type I species include Cherry Laurel, Bald Cypress, American Elm, Hornbeam, Silver Maple, Sugar Maple, Mimosa, Laurel Oak, Pecan, Sweetgum and Sycamore. One may infer from the condition and size of these species that they are the old established trees that have been planted some years ago. These species are mature and will require great care in order to preserve the stock. However, with age an increasing portion of the stock will be subject to the stresses connected with an urban environment. Some species have apparently been restocked. For example, while 56.2 percent of the Live Oaks are "stable, good," 42.2 percent are "vigorous, good," probably indicative of younger, healthier trees. Also, 61.1 percent of the Crape Myrtles in the survey are "stable, good," but 32.6 percent are "vigorous, good."

Another group of species, Type II species, have their largest number of trees represented in the "Vigorous, good" category. These species, which include Small Leaf Elm, Red Maple, and Water Oak, are probably species that have been planted in the recent past. Their average size bears this out. For example, the mean dbh of the Small Leaf Elm is about 5 inches less than the American Elm. Also, the mean dbh of the Red Maple is about 7 inches less than the Sugar Maple and the mean dbh of the Water Oak is about 11 inches less than the Live Oak. Species in Type II will require no special care as a group in the near future.

A third group of species, Type III, includes species which exhibit modal values in the "stable, poor" or "declining, dead" categories. The Golden Raintree, Hackberry, and Washingtonia Palm are all species which are currently in very poor condition. The survey was done during the summer of 1984, which followed a series of freezes during the winter of 1983-84. The poor condition of Golden Raintrees, Hackberries and Palm Trees as a result of the freezes only points to the unsuitability of these species in the New Orleans climate.

While, the poor condition of some species may be explained by their unsuitability, even suitable species

TABLE 2.7

SPECIES CLASSIFIED BY VIGOR

Species	Vigorous Good	Vigorous Poor	Stable Good	Stable Poor	Declining or Dead
Ailanthus	3	1	1	0	0
Arizona Ash	0	0	4	1	0
Green Ash	2	0	0	0	0
White Ash	0	0	1	0	0
Red Bay	0	0	1	0	0
River Birch	0	0	5	3	0
Boxelder	1	0	0	0	0
Red Bud	0	0	2	0	0
Camphor-tree	1	0	0	0	0
Southern Catalpa	2	3	3	0	0
Black Cherry	0	0	2	0	0
Cherry Laurel	0	2	9	0	0
Chinaberry	0	0	5	0	3
Coffee Tree	0	0	0	1	0
Eastern Cottonwood	14	1	4	11	2
Crape Myrtle	86	5	161	9	3
Bald Cypress	4	1	7	0	0
Pine Cypress	2	0	0	0	0
Dogwood	1	0	0	1	0
American Elder	0	0	1	0	0
American Elm	5	1	18	0	1
Small Leaf Elm (Chinese Elm)	23	0	19	0	1
Gingko	1	0	0	0	0
Golden Rain Tree	0	0	3	23	28
Hackberry (Sugarberry)	3	0	5	22	7
Hercules Club	5	0	0	0	0
American Holly	7	0	1	0	0
Possumhaw Holly	1	0	0	0	0
Hornbeam	2	0	15	0	0
Pyramid Magnolia	0	0	3	0	0
Southern Magnolia	19	1	52	1	0
Sweetbay Magnolia	1	0	5	0	0
Red Maple	16	0	2	0	0
Silver Maple	1	0	7	0	0
Sugar Maple	2	0	6	1	0
Mimosa	1	2	7	0	1
Blue Jack Oak	3	0	0	0	0
Laurel Oak	16	0	34	2	0
Live Oak	133	4	177	1	0

TABLE 2.7 (Continued)

SPECIES CLASSIFIED BY VIGOR

Species	Vigorous Good	Vigorous Poor	Stable Good	Stable Poor	Declining or Dead
Cherrybark Oak	0	0	2	0	0
Overcup Oak	1	0	0	0	0
Water Oak	30	2	13	0	0
White Oak	1	0	0	0	0
Willow Oak	0	0	3	0	0
Parkinsonia (Jerusalem Thorn)	1	0	0	0	0
Pecan	5	0	15	0	1
Persimmon	1	0	3	0	0
Podocarp	0	0	3	0	0
Cabbage-Palmetto Palm	4	0	3	0	0
Texas Palmetto	0	0	0	0	1
Loblolly Pine	27	1	60	4	0
Slash Pine	40	0	54	0	0
Spruce Pine	3	0	0	0	0
Silverbell	0	0	1	0	0
Sweetgum	3	0	8	5	0
Sycamore	2	1	14	0	0
Tulip Poplar	2	0	2	0	0
Tung Oil	0	0	0	3	0
Black Willow	0	0	1	0	0
Weeping Willow	0	0	4	0	0
Washington Palm	0	0	2	0	5
All Trees	475	25	747	88	53

Source: Tree Survey

Figure 2.6: Roots of street trees uprooting sidewalk.

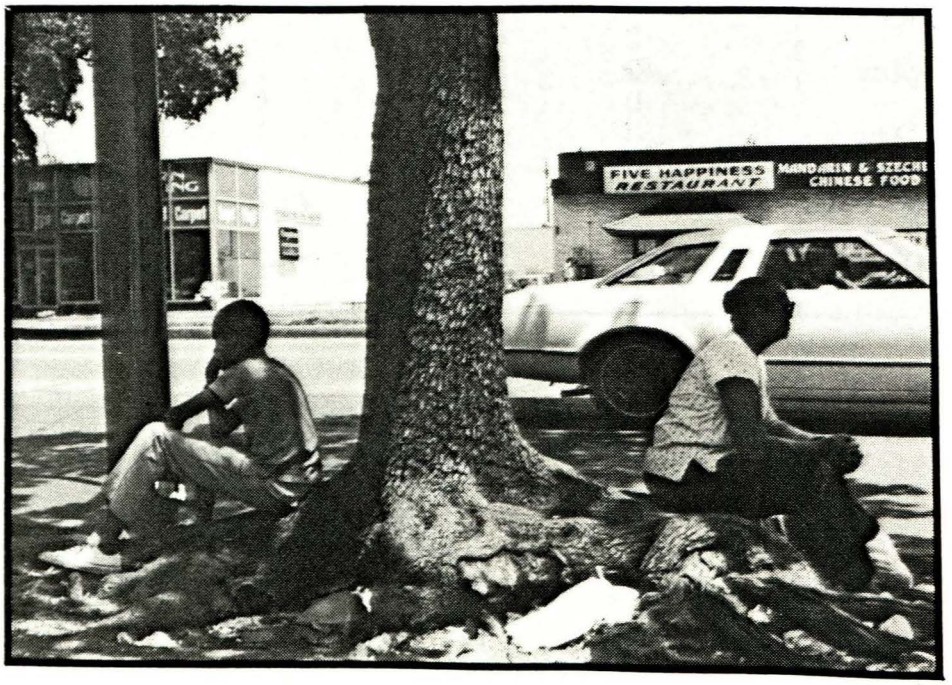

Figure 2.7: Exposed roots of street tree used as a public bench.

exhibit some trees in poor condition. In an attempt to understand the factors that contribute to tree condition, information on each tree's immediate environment was collected for all trees, except dead or severely declining trees. The area under the crown of each tree was classified by the percentage of area which is covered by soil (including ground cover) and by impervious surface (including streets, sidewalks, and buildings). One might hypothesize that trees in the categories indicating good condition and vigor will tend to have a greater percentage of the area below their canopy covered by soil and grass, allowing for soil aeration, movement of water and root growth relatively unhampered by obstructions such as curbs, sidewalks and buildings. Alternatively, it is hypothesized that trees in moderate or poor condition will tend to have a higher percentage of the area under their canopy covered by impervious surfaces, making for difficult growing conditions. Since data on canopy area were not collected for dead or severly declining trees, these hypotheses can only be examined for trees in excellent, good, moderate or poor conditions. Examining the first hypothesis, percent of canopy area covered by soil and grass appears to be related to condition (Table 2.8). Trees judged to be in the two vigorous categories exhibit a higher proportion of the area under their crowns covered with soil than trees in the two stable categories. A priori contrasts point to a statistical relationship ($t= 2.759$, $p=.006$). The second hypothesis also appears to be supported by the data. (Table 2.9). Healthy trees tend to have a lower percentage of the area below the canopy covered by impervious surfaces and less healthy trees tend to have more. The difference in proportion of impervious surface cover is statistically significant between trees in the vigorous categories and trees in the stable categories ($t= -3.43$, $p=.001$).

Another measure of the degree to which competition among trees may effect tree condition is a measure of crown crowding. Trees experiencing crowding by the canopies of other trees are expected to be negatively impacted because tree crowding suggests competition for sunlight, nutrients, and growing space. In the tree survey canopies were examined and an estimate was made of the percentage of each tree's canopy which was touching the canopy of another tree. A hypothesis states that trees in healthy condition categories will have none or a small percentage of their crowns touching other trees, while trees in stable or poor condition will have a larger percentage of their crowns touching the crowns of other trees. A relationship between tree condition and crown crowding does, indeed, exist (Table 2.10). An a priori test that trees categorized as "Vigorous, good" or "Vigorous, poor" experience less crown crowding that trees rated as "Stable, good" or "Stable,

TABLE 2.8

TREE CONDITION AND PERCENT CANOPY AREA COVERED BY SOIL

	Percent Canopy Area Covered by Soil		
Condition	Mean	Standard Deviation	Number
Vigorous good	70.4	25.9	475
Vigorous poor	60.4	32.1	25
Stable good	55.6	25.6	747
Stable poor	58.5	27.6	88

Source	df	Sum of Squares	Mean squares	F ratio	Significance
Between categories	3	64631.22	21543.74	31.95	<.0001
Within categories	1331	897285.13	674.14		
Total	1334	961616.25			

Note: Data not collected for trees categorized as dead or declining.

Source: Tree Survey

TABLE 2.9

TREE CONDITION AND PERCENT CANOPY AREA COVERED BY IMPERVIOUS SURFACE

Percent Canopy Area Covered by Impervious Surfaces			
Condition	Mean	Standard Deviation	Number
Vigorous good	28.7	28.7	475
Vigorous poor	32.0	29.1	25
Stable good	41.3	26.0	747
Stable poor	39.1	27.6	88

Source	df	Sum of Squares	Mean squares	F ratio	Significance
Between categories	3	47173.93	15724.64	21.27	<.0001
Within categories	1331	983923.68	739.24		
Total	1334	1031097.50			

Note: Data not collected for trees categorized as dead or declining.

Source: Tree Survey

TABLE 2.10

TREE CONDITION AND CROWN CROWDING

Condition	Percent of Crown Crowding		
Category	Mean	Standard Deviation	Number
Vigorous good	4.0	13.0	475
Vigorous poor	13.0	26.4	25
Stable good	6.7	9.4	747
Stable poor	7.1	13.3	88

Source	df	Sum of Squares	Mean squares	F ratio	Significance
Between categories	3	3580.47	1193.49	8.866	>.00001
Within categories	1331	179171.34	134.61		
Total	1334	182751.81			

Note: Data not collected for trees categorized as dead, declining.

Source: Tree Survey

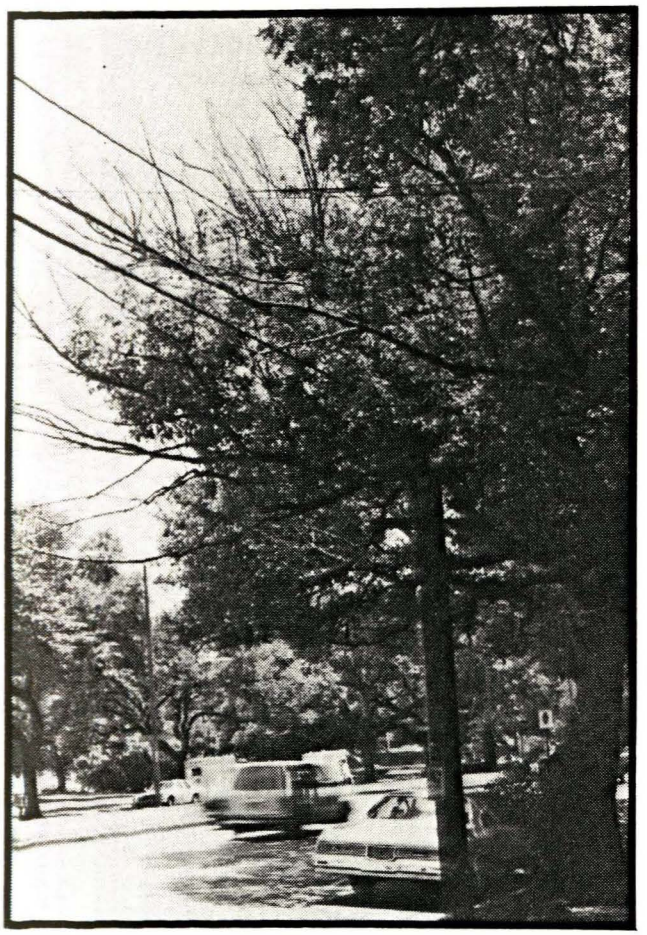

Figure 2.8:
Wires in crown
of mature live oak.

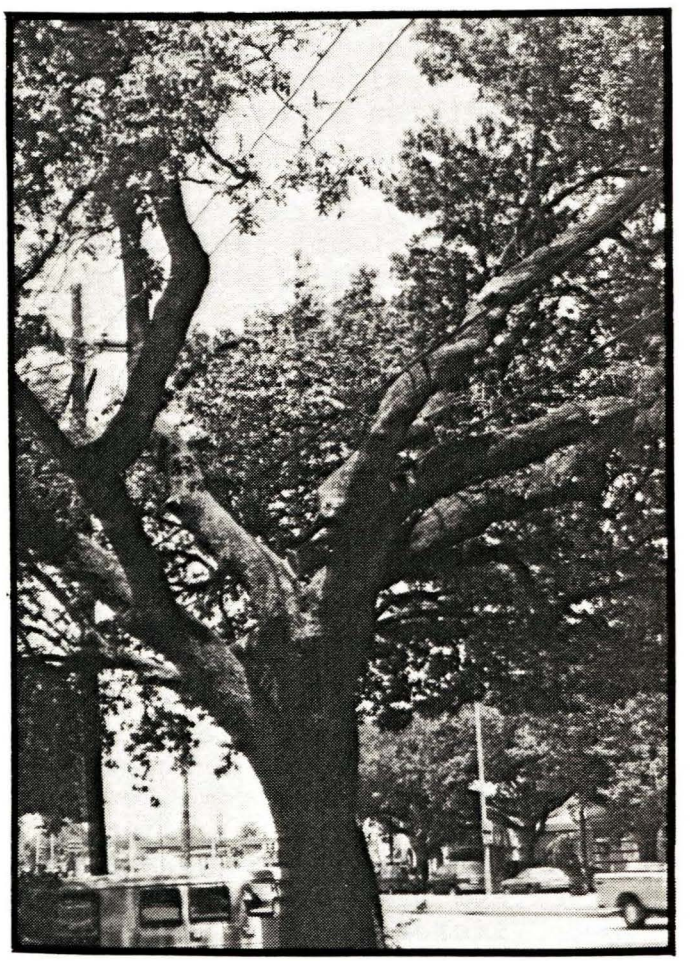

Figure 2.9:
Live oak after branches
near wires have been trimmed,
using "crotch-cut" method.

poor" is not confirmed (t=1.35, p=.242). The relatively small number of trees in the "Vigorous, poor" category suggests that field investigators may have found the "Vigorous, poor" designation a problematical category. Hence, removing that category and contrasting crown crowding between the first category and the third and fourth categories jointly, which are not significantly different in crown crowding (t= .27, p=.787), indicates that the crowns of very healthy trees are less crowded than the crowns of trees in stable condition (t=3.43, p=.001).

Another environmental hypothesis involves land use. It was suspected that trees located on certain land uses or along streets in front of certain land uses should be healthier than other trees. Residential trees may be healthier than commercial, institutional, or industrially located trees because they would receive more care and typically should be located along lower density traffic corridors (both vehicular traffic and foot traffic).

It appears that a relationship between tree condition and land use exists (Table 2.11). Trees located on or near single residential property are less likely to be in good condition than trees located in association with multiple-unit residential property, an unexpected finding. The condition of trees located in or near commercial land uses, parks and vacant or open-space range from vigorous to stable, with approximately equal chance of being in either category. Trees located on or near industrial and institutional land uses are very likely to be in stable, rather than vigorous, condition. These associations between land use and tree condition could result from differential care given to trees, but may result from differences in tree age or other environmental factors.

A very immediate environmental impact experienced by trees is the presence of overhead wires. Often tree prunning or branch removal is required. Hence, an obvious hypothesis is that trees experiencing no impact from wires will be healthier than trees that are impacted by wires. Categories used include "no impact or no wires in the tree," "wires present, minor impact," and "wires present, major impact." Information was not collected for trees in the "dead, declining" category. For all other trees surveyed, only seven experienced major impacts from wires and 501 experienced minor impacts from wires. Thus, the two categories are combined without losing much information. Analysis reveals a significant relationship between tree health and the presence of wires exists. (See Table 2.12.) Trees without wires are more likely to be classified as "Vigorous, good" than trees with wires; while trees impacted by wires are more likely to be classified as "Stable, good." Therefore, wires appear to have a negative impact on the condition, and by implication, health of trees.

TABLE 2.11

TREE CONDITION AND LAND USES

Condition	Number (and Percent) of Trees in Land Use Categories						
	Single Residential	Multiple Residential	Industrial	Institutional	Commercial	Parks	Vacant/Open Spaces
Vigorous (good and poor)	377 (35.8)	64 (64.6)	3 (15.0)	3 (7.0)	30 (49.2)	11 (40.7)	12 (41.4)
Stable (good and poor)	676 (64.2)	35 (35.4)	17 (85.0)	40 (93.0)	31 (50.8)	16 (59.3)	17 (58.6)

Chi-Square = 57.67, d.f. = 6, Significance <.0001

Note: "Vigorous good" and Vigorous poor" are combined and "Stable good" and "Stable poor" are combined in order to minumize the number of empty cells and cells with few cases.

Source: Tree Survey

TABLE 2.12

TREE CONDITION AND THE PRESENCE OF WIRES

Condition	Wires Absent		Wires Present	
	Number	Percent	Number	Percent
Vigorous, good	394	47.6	81	15.9
Vigorous, poor	17	2.1	8	1.6
Stable, good	377	45.6	370	72.8
Stable, poor	39	4.7	49	9.6

Chi Square = 142.6, df.=3, Significance <.0001

Note: Trees classified as "dead, declining" not included in analysis.

Source: Tree Survey

Also, it was thought that management responsibility might be related to tree condition. Trees included in the survey include both trees located on public land which are the responsibility of the city, as well as trees which are located on private land. No reason for suspecting better management by the city or the public is evident. For analysis purposes trees in median strips, park strips and park and open space are aggregated as "publicly-managed trees" and compared to "privately-managed trees." (See Table 2.13). No dramatic difference in tree condition is apparent, although publicly managed trees are somewhat more likely to be concentrated at the extremes of the continuum, either "Vigorous, good" or "Declining, dead." Privately-managed trees tend to be more concentrated in the moderately healthy category, "Stable good." Old and declining trees may be more concentrated on public land than private land, explaining the disparity. Also, private individuals quite likely provide some care to public trees in front of private homes. Interpretation is problematical without data on tree age and patterns of tree care among the public.

Spatial Distribution of the Urban Forest

The spatial distribution of the urban forest in New Orleans, is an important consideration because it suggests to what degree neighborhoods and districts will enjoy the amenities connected with the urban forest. For purposes of analysis Orleans Parish is regionalized into six districts. (The 180 census tracts and 80 officially designated neighborhood units are not appropriate because of their limited areal size and a small number of trees in each unit.) The six districts correspond to aggregations of city planning districts as defined by the City Planning Department. (See Figure 2.10). "Lakefront-Gentilly" corresponds to Planning Districts 1 and 2. "Mid-City-CBD" includes Planning Districts 4 and 8. "Downtown" is comprised of districts 5 and "Uptown" of districts 3,6 and 7. "Algiers," located south of the Mississippi River, includes Planning Districts 10 and 11. New Orleans East, which encompasses a large area of undeveloped marshes and swamps and recent development, corresponds to Planning Districts 12, 13, 14, 15 and 16.

As was reported above, five dominant species in New Orleans (Live Oak, Crape Myrtle, Slash Pine, Loblolly Pine and Southern Magnolia) together account for 60.4 percent of all trees in the sample. The other 56 species identified account for the remaining 39.6 percent. Algiers, Mid City and Downtown exhibit a lower percentage of sampled trees among the five dominant species, indicating an urban forest more diverse than that of the city as a whole (Table 2.14).

TABLE 2.13

TREE CONDITION AMONG PRIVATELY-MANAGED AND PUBLICLY-MANAGED TREES

Tree Condition	Management Responsibility: Privately-managed trees		Publicly-managed trees	
	Number	Percent	Number	Percent
Vigorous good	134	29.1	340	36.9
Vigorous poor	11	2.4	14	1.5
Stable good	279	60.5	466	50.5
Stable poor	26	5.6	61	6.6
Declining Dead	11	2.4	41	4.4

Chi-Square = 16.36, df = 4, Significance = .0026

Source: Tree Survey

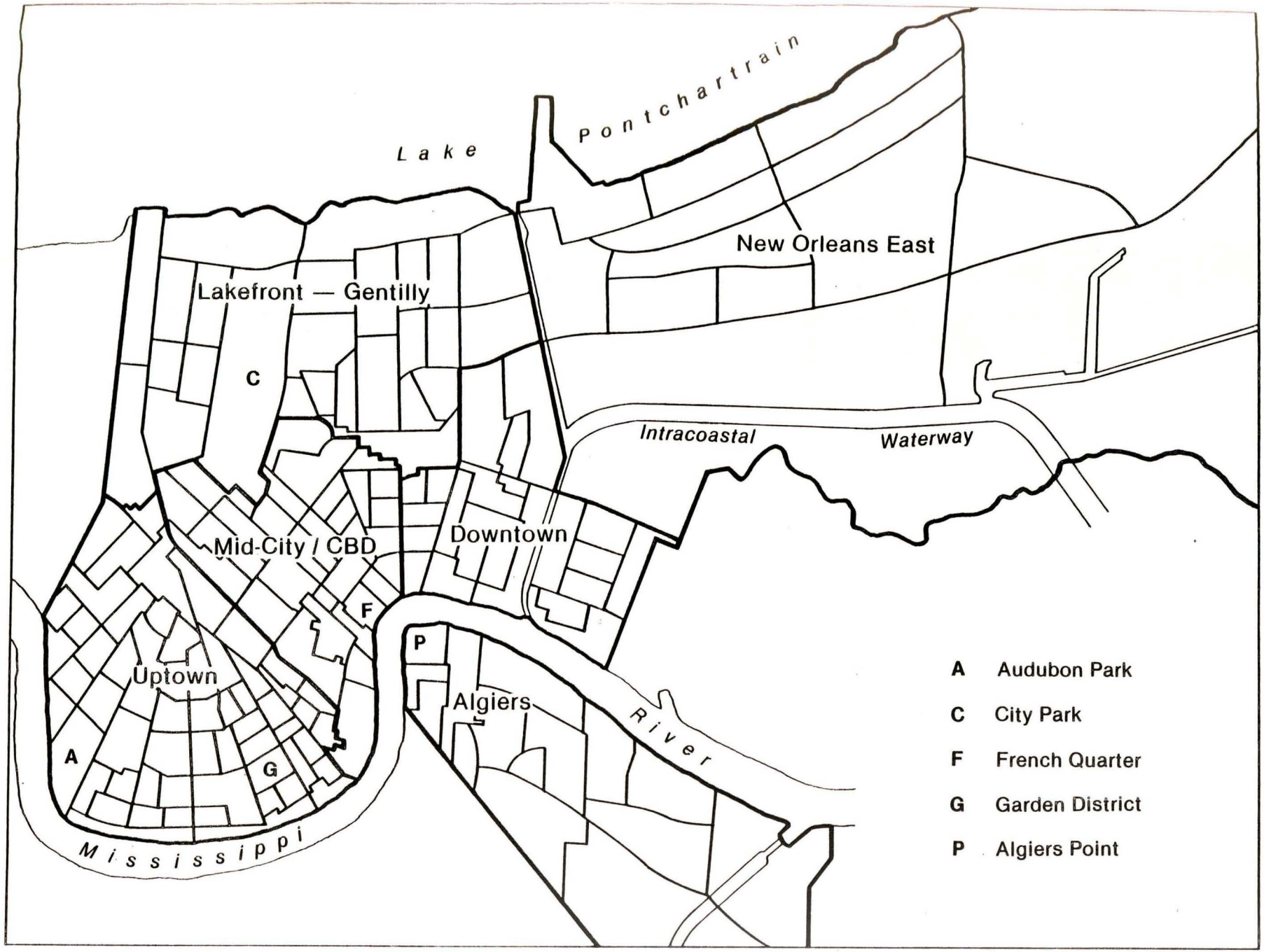

Figure 2.10: New Orleans Census Tracts and Districts.

TABLE 2.14

NUMBER AND PERCENT OF DOMINANT TREE SPECIES
IN SIX NEW ORLEANS DISTRICTS

Dominant Species	District						
	Lakefront Gentilly	Mid-City CBD	Downtown	Uptown	Algiers	N.O. East	Total Number and percent for city
Live Oak	88 (21.7)	29 (20.6)	8 (11.9)	40 (24.8)	29 (14.9)	121 (28.9)	315 (22.7)
Crape Myrtle	109 (26.8)	31 (22.0)	20 (29.9)	33 (20.5)	25 (12.8)	46 (11.0)	264 (19.0)
Slash Pine	28 (6.9)	0 (0)	5 (7.5)	8 (5.0)	4 (2.1)	49 (11.7)	94 (6.8)
Loblolly Pine	18 (4.4)	9 (6.4)	0 (0)	9 (5.6)	27 (13.8)	29 (6.9)	92 (6.6)
Southern Magnolia	27 (6.7)	2 (1.4)	0 (0)	19 (11.8)	12 (6.2)	46 (3.1)	73 (5.3)
All five dominant species	270 (66.5)	71 (50.4)	33 (49.3)	109 (67.7)	97 (49.8)	291 (61.6)	838 (60.4)

Source: Tree Survey

Lakefront-Gentilly, and Uptown, two relatively affluent districts, have urban forests which are less diverse and contain a higher proportion of dominant species than the city average. New Orleans East is about at the city average. In the Lakefront-Gentilly District Crape Myrtle is found in a higher percentage than the city average (26.8 percent compared to 19 percent for the city as a whole). In Uptown Southern Magnolia are found in a higher concentration than the city average (11.8 percent compared to 5.3 percent for the city as a whole). Live Oak may also be more concentrated in Uptown, but the difference is not as great as expected (24.8 percent compared to 22.7 percent). New Orleans East, although close to the city average for percentage of all trees among the five dominant species, has a mix of the five species quite different from the urban average. New Orleans East appears to have a higher concentration of Live Oak and Slash Pine and a lower concentration of Crape Myrtle and Southern Magnolia. Mid-City and the CBD exhibit a lower concentration of Slash Pine and Southern Magnolia than the city as a whole, but since small numbers of trees are involved it may not be a significant difference. Downtown appears to have a lower concentration of Live Oak, Southern Magnolia and Loblolly Pine, but a higher concentration of Crape Myrtle than the city as a whole. Algiers, likewise, has a lower concentration of Live Oak and also a lower concentration of Crape Myrtle, and Slash Pine, but a higher concentration of Loblolly Pine. Some of these generalizations may not represent statistically significant differences and special care should be taken in interpreting differences when a small number of trees are involved. (For this reason all sixty-one species of trees are <u>not</u> included in Table 2.14).

The sizes of trees as measured by dbh (Table 2.15) and height (Table 2.16) vary somewhat by district. The smallest mean dbh and height are found in Downtown and New Orleans East. A posteriori tests indicate that trees in Downtown and New Orleans East differ from trees in other districts because of their smaller dbh and height. (Modified Least Significance tests and Student-Newman-Keuls tests are used in a posteriori comparisons because they allow for unequal group sizes and they are conservative.) The urban forest in New Orleans East is probably younger than in other districts. The dbh's of all other districts is not significantly different. The situation for tree height is somewhat different. The height of trees in Uptown and Algiers is significantly taller than other districts, while the mean height of trees in Lakefront - Gentilly and Mid City - CBD is moderate. In summary, the data analysis indicates that tree biomass is probably greatest in Uptown and Algiers, while it is more modest in Downtown and New Orleans East. People should be able to perceive these

TABLE 2.15

DIAMETER BREAST HEIGHT(IN INCHES IN SIX NEW ORLEANS DISTRICTS

	Diameter Breast Height (DBH)		
Districts	Mean	Standard Deviation	Number
Lakefront, Gentilly	14.4	8.1	406
Mid-City/CBD	14.0	10.4	141
Downtown	11.2	7.2	67
Uptown	15.9	9.6	161
Algiers	16.0	8.2	195
N.O. East	10.6	8.4	418
City	13.5	8.8	1388

Source	df	Sum of Squares	Mean Squares	F ratio	Significance
Between District	5	6384.93	1276.98	17.22	<.0001
Within Districts	1382	102458.5	740.14		
Total	1387	108843.47			

Source: Tree Survey

TABLE 2.16

HEIGHT OF TREES (IN FEET) IN SIX NEW ORLEANS DISTRICTS

	Height		
District	Mean	Standard Deviation	Number
Lakefront, Gentilly	35.3	16.9	387
Mid-City, CBD	32.8	16.7	135
Downtown	30.1	16.6	60
Uptown	38.2	17.7	155
Algiers	41.4	16.5	191
N.O. East	28.7	16.2	409
City	34.0	17.2	1388

Source	df	Sum of Squares	Mean Squares	F ratio	Significance
Between Districts	5	26293.72	5258.74	18.87	<.0001
Within Districts	1331	370925.67	278.68		
Total	1336	397219.37			

Source: Tree Survey

differences as they experience the various districts of New Orleans.

Tree condition appears to differ by district (Table 2.17). A high percentage of trees in New Orleans East (56.9 percent) is classified as vigorous, indicating a healthy and young urban forest. Uptown, Downtown, Algiers and Lakefront - Gentilly have a somewhat lower than average percentage of their trees classified as vigorous, while New Orleans East has a proportion of vigorous trees which is higher than the city average. Conversely, Uptown, Algiers and Lakefront-Gentilly have a higher than average proportion of trees in the stable category, indicative of trees with little or no recent growth. The "declining, dead" category is quite small, making generalizations difficult. The health of the urban forest in the various districts of New Orleans is probably related to the age of the trees; however, lack of data on tree age prevents a definitive explanation.

SUMMARY

In conclusion, the urban forest in the developed portion of New Orleans exhibits considerable species diversity, as well as diversity in form and size. Diversity in age may be safely assumed because of the diverse size data, although data on tree age were not collected. These characteristics differ geographically in New Orleans, suggesting the character of the forest varies by districts in the city. Urban managers may use this information to understand how the urban forest varies throughout the city. They should be cautious, however, in using the information to design management plans for city districts.

Explaining tree condition and health of each tree will depend upon species characteristics and tolerances, as well as immediate environmental conditions which effect tree health in the aggregate. Wires present in trees adversely effect tree health. Also, the crowding of tree crowns appears to have a modest negative impact on tree condition. In addition, the proportion of the land under the tree canopy which is covered by soil and ground cover is related to tree condition. The former is adversely related to tree condition, while the latter appears to be beneficial. Land uses of land near trees or land on which trees are located appears to be related to tree condition in the aggregate. Trees located on or near industrial and institutional (schools, hospitals) land are at greatest risk, followed by trees near single-family residential property. Trees located near commercial land, parks, vacant land or open space and multiple-unit residential land are at a moderate

TABLE 2.17

NUMBER AND PERCENT OF TREES CLASSIFIED ACCORDING TO HEALTH IN SIX NEW ORLEANS DISTRICTS

	Lakefront Gentilly	Mid-City CBD	Downtown	Uptown	Algiers	N.O. East	Total Number and Percent for City
Health Classification							
Vigorous (Good and poor)	112 (27.6)	52 (36.9)	19 (28.4)	34 (21.1)	38 (19.5)	245 (58.6)	500 (36.0)
Stable (Good and poor)	275 (67.7)	83 (58.9)	41 (61.2)	121 (75.2)	151 (77.4)	151 (39.2)	835 (60.2)
Declining, dead	19 (4.7)	6 (4.3)	7 (10.4)	6 (3.7)	6 (3.1)	9 (2.2)	53 (3.8)

Chi-Square = 155.02, df=10, Significance <.0001

Source: Tree Survey

risk. While land use, considered alone, is not a cause of tree condition it may be related to growing space or other environmental conditions or differential management practices. Whether trees are publicly-managed or privately-cared for appears to be related to tree condition, with more publicly-managed trees in extreme good or poor condition.

Many of these findings are obvious, others are unexpected or counter-intuitive. The findings suggest that urban tree managers should direct more attention to wires in trees, to the proper spacing of trees and to the ground or concrete or asphalt under trees. Also, tree maintenance should be targeted at trees near industrial land uses, institutions and near residences, if a uniformly healthy tree population is a goal of tree management in New Orleans. Also, public education efforts should be directed at property owners, but especially residential property owners, in order to encourage them to be active managers of the urban forest.

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CHAPTER 3

VEGETATIVE IMPACTS ON URBAN HYDROLOGY AND TEMPERATURE

Two separate mathematical models, developed by Sanders have been applied to the New Orleans forestry data (Sanders, 1984a and Sanders, 1984b). The models allow for a calculation of impacts in urban hydrology, or run-off, and urban heat island temperatures as a result of changes in urban vegetation. The two models are not meteorological or hydrological models in a strict sense, but rather land use planning and management models. Therefore, the models do not yield precise predictions of air temperatures or water run-off. However, the models are designed to yield projections of the degree to which air temperatures and run-off in a city can be changed by changing the composition of the urban vegetation cover. The air temperature model assumes increasing tree canopy cover will have an ameliorating effect on urban air temperature due to the biological processes of trees (evapotranspiration, for example) and the shade they provide. Similarly, the hydrology model is constructed in such a way to assume that increased tree canopy coverage will decrease water run-off due to the ability of trees to intercept and retain water. An increased density of urban vegetation resulting in decreased storm run-off could benefit a community through less flood damage or decreased expenditures on storm drainage projects. Similarly, increased density of urban vegetation could result in community savings on heating and cooling costs. The two models, however, do not allow for calculations of savings.

Urban run-off and temperatures are evaluated by census tracts for Orleans Parish. Each model measures change as a result of three scenarios of vegetative cover amounts, (1) existing vegetative cover, (2) increased tree canopy cover, and (3) decreased tree canopy cover. Scenario 1 is a census tract's existing cover, which is expressed as a percentage of the census tract covered by tree canopy, herbaceous cover, bare soil and artificial surfaces. Scenario 2 increases the tree canopy cover, assuming half of all land not covered by artificial surfaces is covered by herbaceous cover and half is covered by tree canopy. This is assumed to be a maximum tree stocking level. If one half of the area is already tree cover under existing conditions the tree cover is not increased. Scenario 3 reduces the amount of neighborhood vegetation by assuming the removal of all tree cover and replacing it with herbaceous cover. Bare soil and artificial surface is unchanged in the third scenario. Comparing results of air temperature or run-off between Scenario 1 and Scenario 2 illustrates the impact of increasing neighborhood tree cover, a situation analogous to a very extensive tree planting campaign. Comparing Scenario 1 and Scenario 3 illustrates the impact of a severe reduction in tree cover, if all trees died or were removed for some reason. The models do not constitute a prediction. They are heuristic devices and should not be used outside of the illustrative purpose of this report.

IMPLEMENTING THE MODELS

Data used in the calculations in both models were gathered from black-and-white aerial photography at an approximate scale of 1 to 12000. The census tract boundaries were drawn on the photos, the area of each tract calculated by a planimeter, and ten possible land use categories identified in each tract. Vegetative cover was also identified in each tract, using the following cover types: artificial surfaces (streets, buildings, parking lots, etc.), exposed soil, herbaceous cover (combining tall and short grasses), and tree canopy cover. Additional data incorporated in the models includes soil type and topographic data. This information was found in the Louisiana Soil Survey and a series of USGS Topographic maps covering the parish (U.S. Department of Agriculture, n.d.).

Undeveloped marsh land in New Orleans East is not included in calculations. Marsh land is coded as herbaceous cover, or short and long grasses on undrained or poorly-drained land. The assumption of Scenario 2 requires much of the marsh land to be planted with trees and retained as urban forest, an unrealistic assumption given the public expense of drainage and levee construction. The cost of an artificial drainage system with canals, pumps and levees can only be justified if much of the land is developed as artificial surface (e.g. streets, buildings). Thus, the models are implemented for the developed portion of New Orleans only.

URBAN HYDROLOGY

The urban hydrology model provides for two kinds of predictions for each census tract. First, it estimates the volume of precipitation run-off that results from a representative storm event assumed in the model. For any scenario, the volume of water that runs off a unit of land is equal to the total amount of precipitation received, minus that which infiltrates into the soil or becomes ponded, and that which is trapped on tree canopies or roof tops and subsequently evaporates. Thus, one inch of precipitaiton over a census tract will yield up to one-inch runoff, but typically less (Sanders, 1984b).

Second, it estimates the peak rate of run-off from the same event in each census tract. Factors influencing the rate, in addition to those influencing volume, are topography, channel flow lengths and storm intensity. The model focuses on peak flow, the maximum amount of water that passes a point in a unit of time, where census tracts are regarded as watersheds (Sanders, 1984b). The rate is given in cubic feet per second.

A representative storm event creates the overland flow that results in urban flooding, high rates of soil erosion and surface pollution washoff, and problems in storm sewage handling. In New Orleans, a representative storm event is characterized by 3.5

inches of rainfall in a 6 hour period (Heisfield quoted in Sanders, 1984b, p. 11). The model also incorporates slope, which is not significant in any census tracts in New Orleans. Antecendent soil conditions are assigned values of average saturation levels. For a detailed description of the hydrology model see Sanders (1984b).

In order to illustrate how the hydrology model estimates run-off volumes and potential peak rates, let us examine one New Orleans census tract. Tract 133.01, located in a suburban-like area along Lake Ponchartrain exhibits 20.29 percent artificial surface coverage, 63.05 percent herbaceous coverage, 16.66 percent tree canopy coverage and no bare soil. Tract 133.01 is not typical of New Orleans tracts because it exhibits a much lower proportion of artificial surface coverage and a higher proportion of herbaceous cover than the developed city as a whole, but the tract is useful as an illustration of how predicted run-off changes according to the three scenarios. Scenario 1, the present condition projects total run-off for the assumed representative storm is 1.56 inches, or 1,780,000 cubic feet of water. In Scenario 2, which assumes that more trees have been planted and that all none-surfaced land is half herbaceous and half tree canopy (39.86 percent herbaceous and 39.86 percent tree canopy in tract 133.01) the volume of the run-off is less than Scenario 1 because trees intercept more water. In Scenario 2 the projected volume is 1.48 inches or 1,690,000 cubic feet, a decrease of about 5 percent. In Scenario 3 we assume all trees have been removed and land formerly covered by tree canopy is now covered by grass. Removing all trees causes run-off to increase to 1.64 inches or 1,870,000 cubic feet. Thus, removing trees causes run-off to increase by about 5 percent.

Similarly, the model projects a peak rate under Scenario 1 of 635 cubic feet per second. Increasing tree cover to the level in Scenario 2 decreases the peak rate to a level of 571 cubic feet per second, or 10 percent less than Scenario 1. Removing all trees as assumed in Scenario 3 increases peak rate to a level of 730 cubic feet per second, or about 15 percent higher than Scenario I. Thus, the hydrology model, as expected, projects decreased volume of run-off and peak rate when tree canopy is increased. Also, the model projects an increased volume of run-off and peak rate when trees are stripped away. This conforms with the generally understood idea that trees intercept and retain water better than other types of land cover. Next we examine how the model projects run-off volumes and rates for the entire developed portion of New Orleans.

A hypothetical increase in vegetation, contrasting Scenario 1 and Scenario 2, results in no change in run-off volume in most census tracts (153 tracts or 88.4 percent of the tracts). Among tracts exhibiting a change five decreased the run-off volume as expected. The remainder produced anomalous results. For the whole developed city, run-off volume decreases by 18,900,000 cubic feet, a decrease of only 5.01 percent, using the run-off

estimated in Scenario 1 as a baseline. Decreasing vegetation, contrasting Scenario 3 and Scenario 1, should result in an increase in run-off volume. However, most census tracts (108 or 62.4 percent) exhibit no change. Among the other tracts 57 increased run-off volumes. No geographical pattern is evident. For the city, run-off volume increases 22,070,000 cubic feet, which represents a modest decrease of 5.85 percent of the run-off estimated in Scenario 1.

Increasing vegetation, comparing Scenario 1 and Scenario 2, results in no change in run-off rate in 155, or 89.6 percent, of the census tracts. The average change among the census tracts is only 23.8 cubic feet per second. The areally-weighted mean difference, which measures the change as if the city were a water basin, is only 1209.26 cubic feet per second less. Decreasing vegetation, contrasting Scenario 1 and Scenario 3, resulted in no change in run-off rate in 155 census tracts, 89.6 percent. Fifteen would experience an increase in rate and one a decrease. Again, no spatial pattern is evident. The areally-weighted mean of the flow rate, intended to represent the flow rate for the whole city, is an increase of 133.7 cubic feet per second with decreased vegetation.

URBAN TEMPERATURE

The temperature model creates the ability to compare the difference between urban temperatures and rural temperatures in the surrounding area. Differences in urban-rural temperatures are known as the urban heat island (UHI), a measurement of temperature increases due to urban processes and activities. By modeling the urban heat island as a function of the urban land surface, including degree of vegetative cover, an estimate of noxious heat can be made. Once amounts of heat are determined, management including modification of the urban vegetation, can be effectively employed. Benefits of urban heat island temperature amelioration include a reduction in air-conditioning costs and temperature-related illnessess (Sanders, 1984a).

The computation of the urban heat island temperature for each census tract employs surface characteristics as inputs and temperature as outputs. Each census tract was evaluated using the three scenarios. In New Orleans all land area has less than 3% slope, therefore north and south facing slopes are not an important issue. Land use categories and vegetative cover type data were gathered as part of the hydrology model process. The equations for rural and urban temperatures were calculated for the three scenarios in each census tract. Increasing vegetation density, comparing Scenario 1 and Scenario 2, should decrease the heat island effect. However, temperatures are unchanged in 133, or 76.9 percent of the census tracts. Among others, increased or decreased temperatures are modest. Only two tracts would experience a decrease in temperature by more than one degree Fahrenheit. Calculating the air temperature change for the city

as a whole, the areally-weighted mean of all census tracts results in a temperature lower by .0397° F, not a significant change. Decreasing vegetation, contrasting Scenario 3 and Scenario 1, should increase the heat island temperature. The expected result would occur in all but 28 census tracts. Once again, calculating the areally-weighted mean which represents the temperature change in the city as a whole, the temperature increases by only .296° F, a rather insignificant change. On the whole, the performance of the air temperature model fails to provide convincing results of a change in temperature resulting from vegetation changes.

CONCLUSIONS

The implementation of the temperature and hydrology models in New Orleans indicates a modest change in run-off and air temperatures as a result of changing land cover. The small changes in run-off and temperature produced in small numbers of census tracts might even be characterized as random noise (e.g. measurement error or rounding-off numbers in the many calculations), rather than truely significant results. Or, the failure of the models to produce dramatic results may be due to the relatively dense tree canopy in New Orleans. Many census tracts exhibit maximum tree stocking levels in Scenario 1, resulting in no change in vegetation between Scenario 1 and Scenario 2. Alternative explanations might involve the configuation of rural land uses, the lack of significant slopes, or other unique characteristics of New Orleans may cause the models to lack sensitivity to differences in temperatures and run-off between alternate scenarios. In any case, since the models are simulation exercises, their failure to produce significant results does not disprove any hypotheses about causal connections between urban vegetation and run-off or vegetation and the urban heat island.

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CHAPTER 4

THE URBAN FOREST AND THE ENVIRONMENTAL AND SOCIAL CONTEXT

In an attempt to understand the relationships between the New Orleans urban forest and the physical environment of the city, as well as the socioeconomic environment, data were collected by census tract. The physical environment is understood to refer to the configuration of the built environment, including the form and distribution of land uses, buildings, streets, and open spaces. The physical environment also includes the biological, topographic, and climatic aspects of the environment,especially tree canopy, the principal interest of this study. This physical environment is the matrix within which the urban forest grows. The urban forest also exists within a socioeconomic matrix, according to the geography of where people of various classes and categories live, work, play, and travel.

DATA ASSEMBLY

Information on the socio-economic and certain physical characteristics is available by census tract (U.S. Department of Commerce, Bureau of the Census, 1983a), neighborhood areas (U.S. Department of Commerce, Bureau of the Census, 1983b), and land use planning district (New Orleans City Planning Commission 1983). Census data was chosen for the analysis because the census tracts provided a manageable size for data interpretation and census data furnished the greatest number of variables for analysis purposes. The census gives information on the built environment such as number of single housing units, double housing units, multi-unit buildings, rental units, condominium units, mobile homes vacant units, and number of units built in various time periods. Socioeconomic information includes a range of variables measuring racial composition, age group composition, income, employment, and travel to work by census tract.

Land uses were distinquished on black and white aerial photos of 1:12,000 resolution taken in 1980. Visual interpretation of existing land uses was performed with the aid of 1980 proposed land use maps provided by the City Planning Commission. Field checking and air photo interpretation created an existing land use data set. Census tract boundries for 178 tracts were first transposed on to the photographs. The tracts were than divided into ten land use categories as either 1)single and two family residences,

2)multi-family residences, 3)commercial, 4)industrial, 5)institutional, 6)parks, 7)vacant or open land, 8)agriculture, 9)transportation, and 10)miscellaneous. Water was not distinquished as a seperate land use as it did not represent a change in usage from surrounding uses of land. For example, water in canals was included in the industrial category because it is managed as part of the industrialized area. Land area which was found to be swamp in the unurbanized areas was classified as miscellaneous. The land use polygons identified in each census tract were then planimetered and polygons of the same land use category were summed for each census tract.

In addition, the land use polygons were visually interpreted into percentages of cover type in order to provide an indication of potential stocking levels of canopy. The polygon cover was categorized as (1) tree canopy, (2) herbaceous cover, mostly grass but also other types of low ground cover (3) bare soil, or (4) artificial surface, including buildings, sidewalks, streets, parking lots. Percentages of cover type were estimated to the nearest one percent. The data were than tallied by census tract for each cover type in each land use category. In total, the data base includes land use polygons, acres of land use polygon types, percentage of census tract area in each land use category, and percent of cover type per census tract and land use category.

DESCRIPTION OF LAND COVER AND LAND-USE RELATIONSHIPS

A study of the ecology (natural and built environment) and the human ecology (built environment and socioeconomic structure) of the urban forest has a small body of research on which to draw. Researchers have not yet examined the relationship between the urban forest and urban social geography. USDA Forest Service research in Syracuse, Dayton,Cincinnati, and Birmingham demonstrates certain regularities in tree canpoy cover by land use category (Sanders, 1984; Rowntree, 1984; Sanders and Stevens,1984; and Richards, Mallete, Simpson, and Macie, 1984).

In Orleans Parish, which is coterminous with the City of New Orleans, 58.92 percent of the land area is covered with herbaceous cover, 29.59 percent is surfaced, 11.15 percent is covered with tree canopy, and only .39 percent is bare soil. Excluding portions of New Orleans in New Orleans East and the Lower Coast of Algiers not yet developed as urban land uses, the picture is very different. For the developed portion of the city only, 62.24 percent is covered with artificial surfaces, 21.24 percent is tree canopy cover, 16.40 percent is herbaceous ground cover, and .97

percent is bare soil. (The mean percentages by census tracts for the developed portion of the city are 73.09 percent artifical surface, 16.74 percent tree canopy, 9.27 percent herbaceous cover, and .89 percent bare soil.) Obviously, the percent of an area covered with tree canopy can only be increased if the percentages of other cover types is diminished. Realistically, the best opportunity for increasing tree canopy cover is at the expense of herbaceous vegetation and bare soil. Replacement of artificial surfaces with trees is economically unlikely, except for demolition of old residential structures and replacement by greenspace (Talarchek,1980). The spatial distribution of the four types of land cover constitutes an important aspect of the physical environment of any city.

As can be seen by an examination of the geography of tree canopy (see Figure 4.1), in most sections of New Orleans tree canopy covers less than 20 percent of the surface area. (See Figure 2.2 for a locater map of New Orleans' districts and parks.) Neighborhoods exhibiting higher tree canopy density can be found in Uptown, especially in the vicinity of the Garden District and Audubon Park; the area of the city south of the Mississippi River, except for Algiers, the oldest part of the district; portions of Mid-City; areas of the city east and west of City Park and portions of recently developed New Orleans East. Herbaceous ground cover (see Figure 4.2) is present in relatively modest proportions of land surface over most of the city. City Park and Audubon Park are areas of high concentration, along with underdeveloped land in New Orleans East. Other grassy areas include several neighborhoods along the Lakefront. Such neighborhoods with high concentrations of herbaceous ground cover represent areas of opportunity for increased tree cover. Indeed, several Lakefront neighborhoods are not old enough for the urban trees to have reached great size. Most likely tree canopy cover will increase as a proportion of all land cover in the Lakefront area. The geography of artificial surface cover (e.g. streets, buildings, driveways, parking lots and sidewalks) (see Figure 4.3), reflects dense development in the oldest areas of the city and less dense development in traditional high status areas and those areas more recently developed. The highest proportion of land surface covered with streets, buildings and sidewalks is in the Central Business District, French Quarter, Downtown, Algiers Point, and portions of Mid-City, Uptown, and Gentilly. Opportunities for significant afforestation in areas with high artificial surface cover are limited by the lack of potential growing space. However, public and private redevelopment in those areas may present isolated opportunities if tree planting is encouraged in site designs for new commercial and residential projects. Bare soil

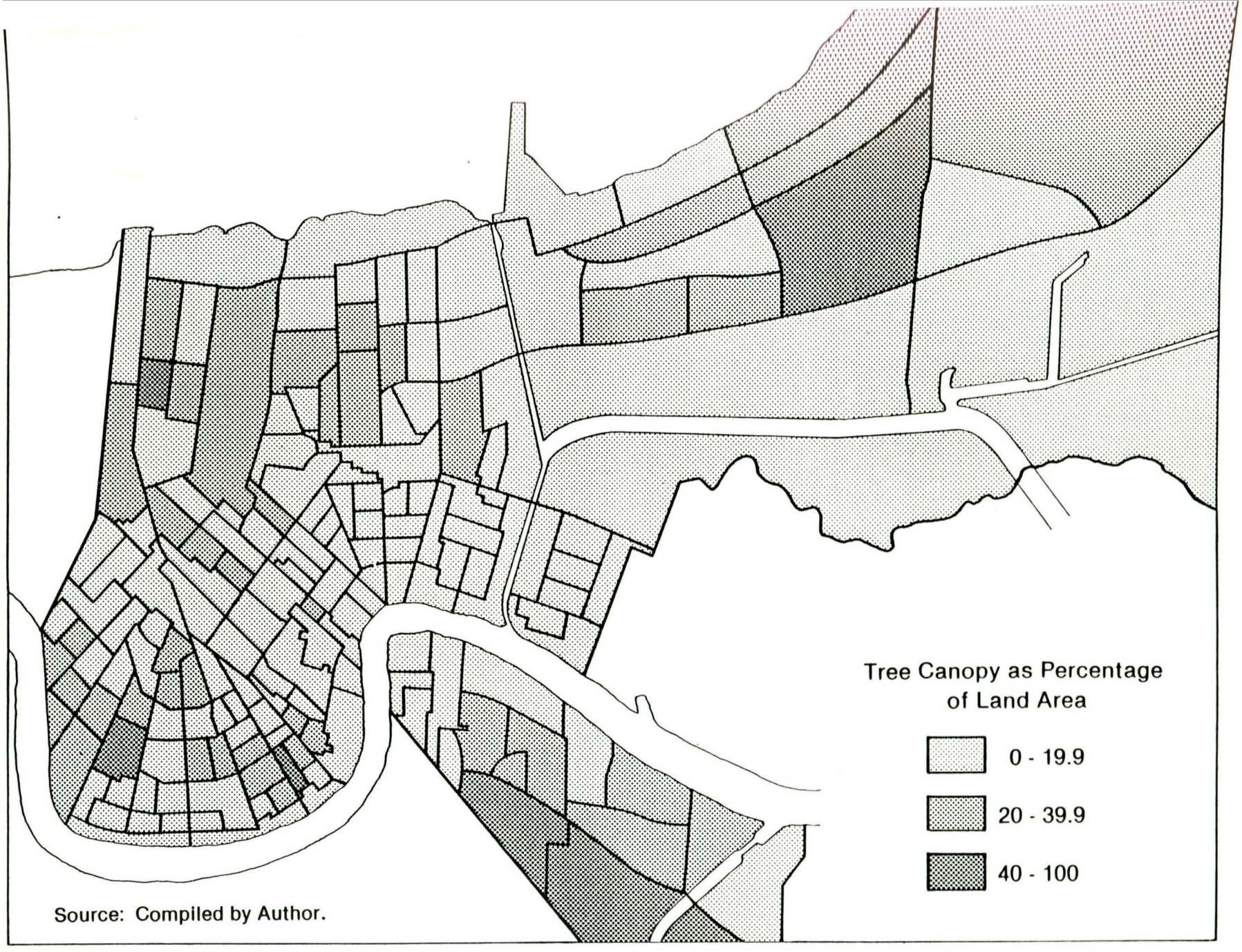

Figure 4.1: Tree Canopy Cover by Census Tract as a Percentage of Land Area.

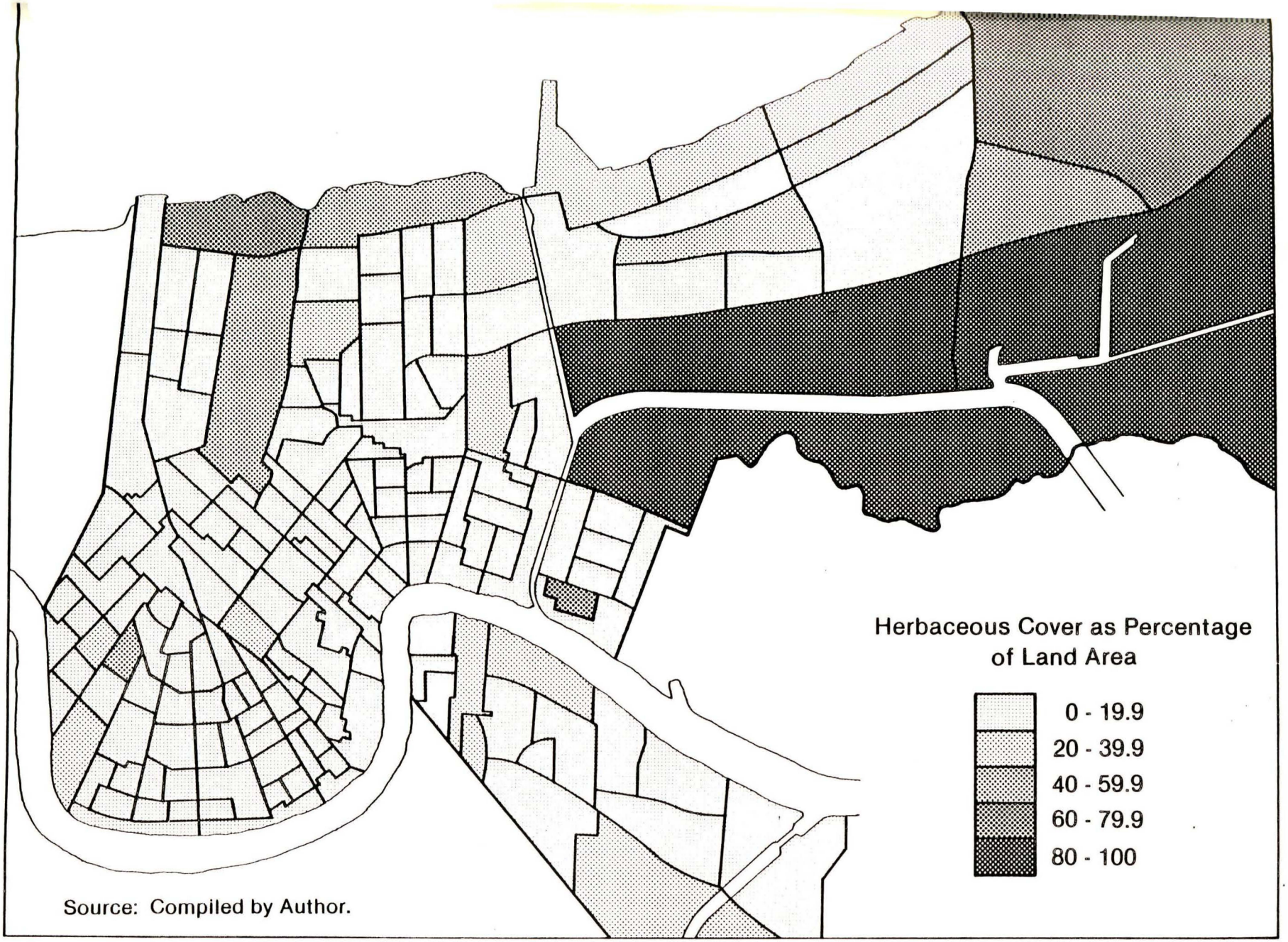

Figure 4.2: Herbaceous Cover by Census Tract as a Percentage of Land Area.

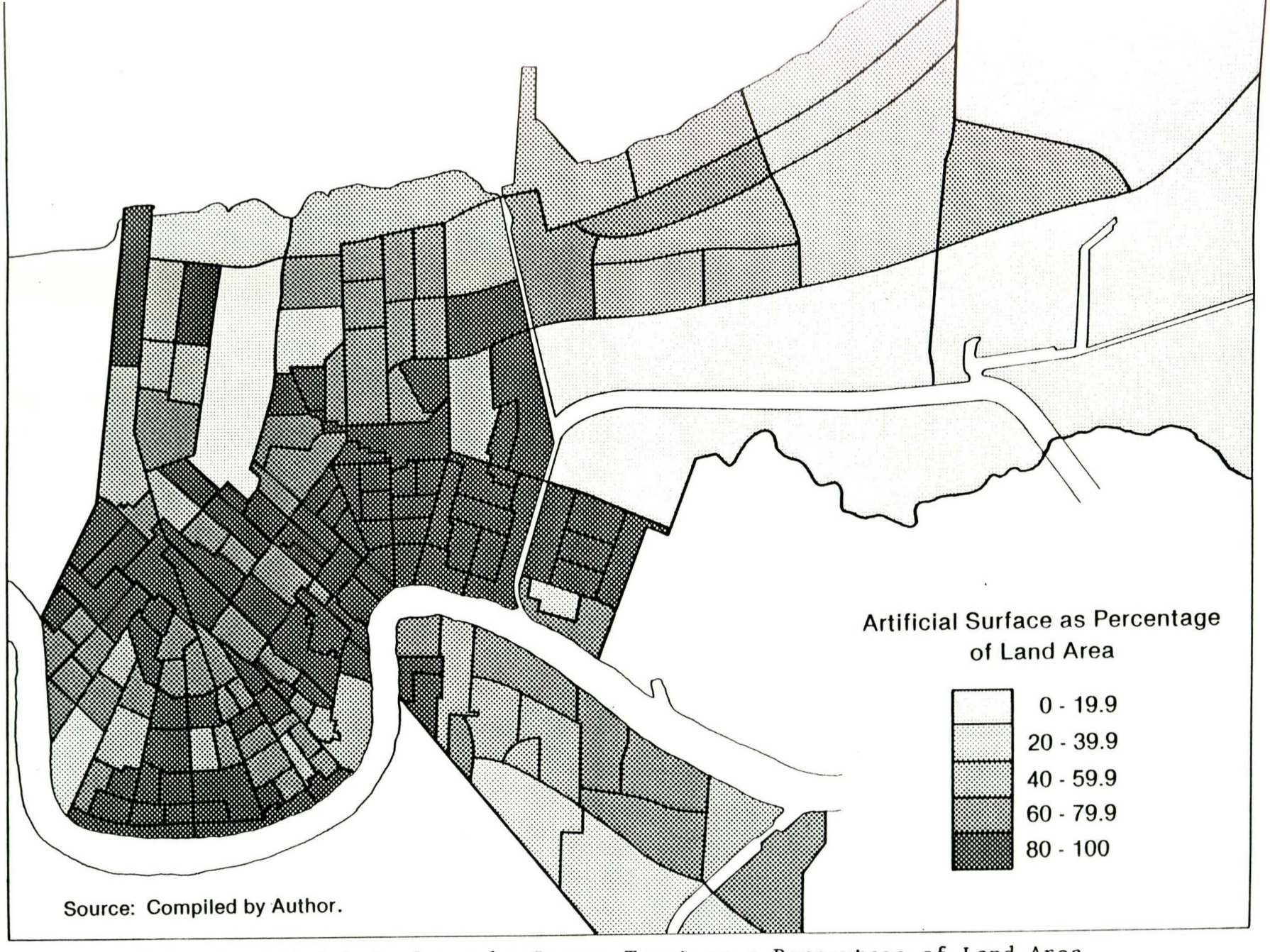

Figure 4.3: Artificial Surfaces by Census Tract as a Percentage of Land Area.

represents a small portion of the total land cover in New Orleans. Only 30 census tracts have bare soil at all and it represents only a small percentage of the land in those census tracts.

Examining the proportion of the four cover types of each of the ten land use categories demonstrates the high proportion of the land in Orleans parish which is undeveloped. Most of the undeveloped land is located in New Orleans East and a smaller tract is located along the Lower Coast of Algiers. Less than half of the total land area of New Orleans is developed in urban land uses. About 12 percent is vacant or open space and 47.77 percent is classified as miscellaneous. Vacant land includes demolition sites and underdeveloped land in the developed portions of the city. The miscellaneous category consists of marsh and swamp land not appropriate for urban development without substantial public investment in drainage and flood protection systems. As expected the undeveloped marsh land is almost totally covered with herbaceous ground cover. Almost none of the miscellaneous land is covered with artificial surface (i.e. roads). Hence, according to the definition of available growing space and canopy stocking used here (see Table 4.1), almost all the marsh area is availabale for afforestation. In reality, however, most of the land is either under water or so poorly drained that extensive tree planting is not feasible. Selected tracts of vacant land may present some opportunity for afforestation. Agricultural land comprises a very small proportion of all land in New Orleans.

Among the urban use categories much of the land is covered with artificial surface, with the exception of urban parks. Industrial and commercial land is most densely developed and exhibits low tree canopy cover and a relatively low percentage of available growing space. Industrial land, however, exhibits a low level of canopy stocking and probably presents some opportunities for tree planting. Parks and institutions exhibit tree canopy stocking levels of 37 percent and 27 percent, respectively, suggesting more trees can be planted in parks and on institutional grounds (such as schools, universities, hospitals and government buildings). Residential land uses are relatively densely canopied, especially single and double-family residential land.

ANALYSIS OF LAND COVER AND URBAN GEOGRAPHY

Since urban forestry as a scientific research endeavor is a relatively new field, theory on relationships between the urban forest and the physical and socioeonomic

TABLE 4.1

PERCENTAGE OF LAND-USE CATEGORIES AND LAND-COVER TYPES IN NEW ORLEANS

Land use class	Percent of all land	Percent of land-use categories					
		Tree Canopy	Herbaceous Cover	Artificial Surface	Bare Soil	Percentage of available growing space[a]	Canopy Stocking[b]
Residential, 1-2 family	18.92	22.49	8.34	68.92	.25	31.08	72.36
Residential, multifamily	2.35	18.63	12.26	68.93	.18	31.07	59.96
Commercial	3.28	9.14	6.92	82.94	1.00	17.06	53.57
Industrial	6.02	5.28	21.02	72.43	1.27	27.57	19.15
Institutional	4.87	13.16	34.75	51.39	.70	48.61	27.07
Parks	3.24	32.34	53.24	12.75	1.67	87.25	37.06
Vacant	12.00	25.58	45.74	27.71	.96	72.29	35.38
Agriculture	.60	35.00	55.00	5.00	5.00	95.00	36.84
Transportation	.94	0	.18	99.82	0	.18	0
Miscellaneous[c]	47.77	1.95	97.08	.97	0	99.03	1.97

[a]Calculated as that proportion of polygons not covered by artificial surfaces.

[b]Calculated as that proportion of available growing space presently occupied by canopy.

[c]Comprised of marsh and swamp land.

environments of cities does not yet exist. Given the absence of specific theory on the topic under investigation, the statistical analysis must be considered exploratory. The strategy in the following analysis is to begin with the most exploratory technique and progress to less exploratory and more confirmatory mehtods of analysis.

The initial analysis examines the spatial distribution of the urban forest as one part of the wider physical and social geography of the city, while subsequent analysis focuses more closely on the urban forest as the phenomenon to be explained. Accordingly, the first step is an exploratory factor analysis of the physical and social geography of New Orleans. Eliminating those variables found not to be related to land cover, the next step is a canonical correlation which attempts to account for land cover by using variables descriptive of the land-use and socioeconomic geography of New Orleans. The final step is to account for the distribution of the urban forest, using regression analysis, the most confirmatory of the statistical techniques. The sum of the techniques will produce an understanding of the urban forest to other forms of land cover and to the physical and socioeconomic matrix within which the forest exists.

Factor analysis is useful in order to discover which variables in the data set form coherent subgroups (Tabachnick and Fidell, 1983). Inspection of these resulting subgroups of variables will yield insight into the structure of the urban forest in New Orleans, and possibly insights into the processes that generated the urban forest. Factor analysis is used rather than principal components analysis because factor analysis analyzes covariance, while PCA analyzes variance (Tabachnick and Fidell, 1983, p. 397). Factor analysis uses the variance that each variable shares with other variables and excludes variance due to error or unique sources of variablility. Since the goal of the research is to examine the broad relationship between the urban forest and physical and socioeconomic environments, rather than account for error or unique qualities of census tracts, factor analysis is deemed more appropriate. The R solution to factor analysis is appropriate in this context. Varimax rotation is used in order to extract factors which can be more easily interpreted.

A number of variables indicative of the socioeconomic and housing geography of New Orleans, as well as land-use variables are included. (See Table 4.2). Initially, variables were checked for outliers among cases. Some potential variables were eliminated because concentrations in only a few census tracts caused distributions to be highly skewed. Examples include percentages of persons who

TABLE 4.2

VARIABLE NAMES AND EXPLANATION

Variable Name	Explanation
PCANO	Percent census tract area covered by tree canopy
PHERB	Percent census tract area covered by herbaceous ground cover
PSOIL	Percent census tract area covered by bare soil
PSURF	Percent census tract area covered by artificial surface
PSRES	Percent census tract area, single and double family residences
PMRES	Percent census tract area, multi-unit residial (apartments)
PCOMM	Percent census tract area, commercial
PINDU	Percent census tract area, industrial
PINST	Percent census tract area, institutional
PPARK	Percent census tract area, parks
POPVA	Percent census tract area, open space and vacant
PAGRI	Percent census tract area, agriculture
PTRAN	Percent census tract area, transportation
PHU50	Percent housing units in buildings having 50 or more units
PHU10T49	Percent housing units in buildings having 10 to 49 units
PHU5T9	Percent housing units in buildings having 5 to 9 units
PHU3T4	Percent housing units in buildings having 3 to 4 units
PHU2	Percent double units
PHU1	Percent single units
PRENTAL	Percent of all housing units rental units
PCONDO	Percent of all housing units condominum units
PMOBH	Percent of all housing units mobile homes
P39	Percent of all units built 1939 or earlier
P40T49	Percent of all units built 1940 to 1949
P50T59	Percent of all units built 1950 to 1959
P60T69	Percent of all units built 1960 to 1969
P70T80	Percent of all units built 1970 to 1980
CTAREA	Census tract area (in 100s of acres)
TOTPOP	Total population (in 100s of persons)
NOHH	Number of households (100s)
SRATIO	Sex Ratio
PWHITE	Percent of population white
PBLACK	Percent of population black
PAMIN	Percent of population American Indian
PHISP	Percent of population Hispanic
PUNDER5	Percent of population less than 5 years
P5T17	Percent of population 5 to 17 years of age
P18T64	Percent of population 18 to 64 years of age
P65OVER	Percent of population 65 or older
MAGE	Median age
PMARM	Percent males, married
PMARF	Percent females, married
PFAMHH	Percent family households
PNFAMHH	Percent non-family households
PINMATE	Percent inmates of institutions
PGROUPQ	Percent living in group quarters

TABLE 4.2 (continued)

VARIABLE NAMES AND EXPLANATION

Variable Name	Explanation
PSINGHH	Percent single-person households
PVAC	Percent units vacant
PVACSALE	Percent units vacant for sale
PVACRENT	Percent units vacant for rent
PVACUSE	Percent units vacant for occasional use
PCONDOR	Percent condominium units for rent
PSTBORN	Percent born in the state
PFOBORN	Percent foreign born
PMANG	Percent employed in managerial occupations
PTECH	Percent employed in technical occupations
PSERV	Percent employed in service occupations
PFARM	Percent employed in farm/fishing occupations
PPREC	Percent employed in precision work occupations
POPRT	Percent employed as operators
PMIG	Percent living at another address in 1975
PCOLL	Percent persons 25 years or older with 1-4 years of college education
PHSG	Percent persons 25 years or older with high school diploma
MTTIME	Mean travel time to work
PAUTO	Percent riding auto alone to work
PPOOL	Percent riding in car pool to work
PPTRN	Percent using public transportation to work
PWALK	Percent walking to work
MVALUE	Median value of house (in $1000s)
MRENT	Median contract rent (in $10s)
MEDINC	Median household income, 1979
PPOV	Percent living at or below poverty level
PROOM	Median number of rooms
MPUNIT	Median number of persons per housing unit
NOHH	Number of households (in 100s)

identified themselves as Pacific Islanders, Eskimos, Hawaiians, Samoans, Vietnamese, Guamian and "Other".

The factor analysis with varimax rotation produced 16 factors (see Table 4.3). The factors collectively explain 81.2 percent of the variance; the first 4 factors together explain almost half of the variance. The variables of most interest are PCANO, PHERB, PSOIL, and PSURF, the variables measuring the percents of each census tract covered by tree canopy, herbaceous cover, soil and artificial surface, respectively. The land cover variables only load on a few of the factors. Factor 1 includes PCANO, PSURF and a variety of variables such as percent white (positive), percent black (negative), percent 18 to 64 (positive), percent employed in managerial and technical occupations (both negative), median house value (positive), median rent (positive), and median income (positive), indicating that the factor measures socioeconomic status. Thus, the urban forest appears to be more highly concentrated in high status, high income, white neighborhoods.

Factors 2 through Factor 8 and Factors 10 through 12 appear to represent other important dimensions of the New Orleans physical and socioeconomic environment unrelated to the urban forest, such as life cycle, single-person poverty, poverty among families with children, large families, outlying fishing neighborhoods, technical occupations, housing built in the period 1950 to 1969, housing built in the period 1940 to 1959, blue collar families, prisons, and non-hispanic neighborhoods. Factor 9 includes herbaceous cover (positive), artificial surface (negative), census tract area (positive), vacant housing for occasional use (positive), and percent employed as precision workers (positive). The factor seems to be indicative of surburban-type blue collar neighborhoods. Factor 13 is clearly indicative of parks because of the positive loading on tree canopy, herbaceous cover, parks, and negative loadings on artificial surface. Factor 14 is a factor of industrial areas, which exhibit bare soil and little tree canopy. Factor 16 is a factor of institutional land uses, which also are negatively related to tree canopy.

Using factor analysis as a hypothesis generating procedures leads to a number of avenues to continued analysis. First, the distribution of the urban forest and other land cover categories in New Orleans appear to be largely explained by the socioeconomic status and racial

composition of neighborhoods. Certain age groups may also be related. Secondly, the residual variance in the urban forest not explained by socioeconomic status can be accounted for by land uses in neighborhoods, especially the presence or absence of apartments, parks, institutions, industries and vacant or open space. Canonical correlation is used to focus on these hypotheses.

The four variables measuring percentages of land covered by artificial surface, tree canopy, herbaceous cover, and soil, will constitute a set of dependent variables; variables consisting of indicators of the form of the built environment and soioeconomic environment will constitute a set of independent variables. Canonical correlation is used to analyze the relationships between two sets of variables in order to determine to what extent one set of variables can be explained by another set of variables (Thompson, 1984). Canonical correlation generates canonical variates, which are pairs of linear combinations of variables from each of the two sets of variables (Tabachnick and Fidell, 1983).

One important limitation on using canonical correlation in the present context is the stipulation that variables within each set should not be too highly correlated with each other, or near linear combinations of others (Tabachnick and Fidell,1983 p. 150). This can be tested by inspecting a correlation matrix of bivariate correlation coefficients and by producing a set of multiple regressions in which each variable is alternately a dependent variable and one of a set of independent variables for the set of variables (Tabachnick and Fidell, 1983, pp. 81-83). Multiple regressions reveal that PCANO, PSURF, PHERB and PSOIL are all multicollinear. This finding is expected because the variables taken together account for 100 percent of the land area of each census tract and of the entire city. Clearly, at least one variable needs to be removed. An inspection of the bi-variate correlation matrix below indicates that PSURF (percent artifical surfaces) is most highly correlated with PHERB (percent hebaceous cover) and PCANO (percent tree canopy). Other bi-variate correlation coefficients are quite low. Therefore, PSURF is not included in the set of dependent variables. This creates no theoretical or interpretive problems since the focus of the analysis is the vegetative environment, rather than the built environment.

TABLE 4.3

VARIMAX FACTOR LOADINGS

Factor 1		Factor 2		Factor 3	
Eigenvalue 14.7		Eigenvalue 10.7		Eigenvalue 5.8	
Variance Exp. 19.9%		Variance Exp. 14.4%		Variance Exp. 7.9%	
Variable	Loading	Variable	Loading	Variable	Loading
PCANO	.47	PSTBORN	.70	PSRES	-.46
PSURF	-.40	PMANG	.89	PHU5T9	.70
PMRES	-.32	PTECH	.54	PHU3T4	.52
PHU1	.34	PSERV	-.69	PRENTAL	.37
PRENTAL	-.52	POPRT	-.74	PMARM	-.55
PWHITE	.87	PHSG	.93	PMARF	-.44
PBLACK	-.85	MTTIME	-.49	PNFAMHH	.40
PHISP	.32	PAUTO	.54	PSINGHH	.33
PUNDER5	-.63	PPTRN	-.64	PSTBORN	.33
P5T17	-.53	MVALUE	.77	PAUTO	-.50
P18T64	.59	MRENT	.84	PPTRN	.34
MAGE	.50	MEINC	.83	PWALK	.76
PMARM	.54	PPOV	-.75	PPOV	.31
PMARF	.58	MROOM	.58		
PVACSALE	.34				

Factor 4		Factor 5		Factor 6		Factor 7	
Eigenvalue 5.2		Eigenvalue 4.2		Eigenvalue 2.8		Eigenvalue 2.4	
Variance Exp. 7.0%		Variance Exp. 5.8%		Variance Exp. 3.8%		Variance Exp. 3.2%	
Variable	Loading	Variable	Loading	Variable	Loading	Variable	Loading
PCOM	-.38	PSRES	-.42	POPVA	.86	TOTPOP	.81
P18T64	-.31	PMRES	.55	PAGRI	.90	PUNDER5	.33
PFAMHH	.44	PHU50	.54	PTRAN	.93	P5T17	.36
PGROUPQ	-.79	PHU10T49	.74	PMOBH	.75	PTECH	30
PFOBORN	-.95	PHU5T9	.32	PFARM	.75	MTTIME	.58
PMIG	-.95	PHU2	-.45	PPTRN	.93	MROOM	.35
PHSG	-.77	PHU1	-.51			MPUNIT	.52
MTTIME	.39	PRENTAL	.42			NOHH	.79
MROOM	.37	PCONDO	.76				
MPUNIT	.30	P70T80	.31				
		PUNDER5	.31				
		PCONOR	.73				
			.31				

TABLE 4.3 (continue)

VARIMAX FACTOR LOADINGS

Factor 8		Factor 9		Factor 10		Factor 11	
Eigenvalue 2.3 Variance Exp. 3.1%		Eigenvalue 2.0 Variance Exp. 2.7%		Eigenvalue 1.9 Variance Exp. 2.5%		Eigenvalue 1.5 Variance Exp. 2.1	
Variable	Loading	Variable	Loading	Variable	Loading	Variable	Loading
PHU3T4	-.34	HERB	.59	P40T49	.72	PMARF	.34
PHU2	-.64	PSURF	-.35	P70T80	-.46	PVACSALE	.50
P39	-.71	CTAREA	.85	PVAC	-.41	PPREC	.82
P50T59	.75	PVACUSE	.75	PVACRENT	-.32	PPOOL	.59
P60T69	.46	PPREC	.33				
PNFAMHH	-.31						

Factor 12		Factor 13		Factor 14		Factor 15	
Eigenvalue 2.0 Variance Exp. 2.7%		Eigenvalue 1.3 Variance Exp. 1.8%		Eigenvalue 1.3 Variance Exp. 1.7%		Eigenvalue 1.2 Variance Exp. 1.7%	
Variable	Loading	Variable	Loading	Variable	Loading	Variable	Loading
SRATIO	.75	PCANO	.38	PCANO	-.35	PHU	-.35
P18T64	.45	PHERB	.51	PSOIL	.65	PHISP	-.61
PINMATE	.87	PSURF	-.63	PINDU	.82	PVACRENT	-.45
		PSRES	-.33				
		PPARK	.83				

Factor 16	
Eigenvalue 1.0 Variance Exp. 1.4%	
Variable	Loading
PCANO	-.33
PINST	.72

Note; Factor loadings less than .3 omitted.

TABLE 4.4

BI-VARIATE CORRELATION COEFFICIENTS
OF THE DEPENDENT SET OF VARIABLES

PSURF	1.0			
PSOIL	-.110	1.0		
PCANO	-.618	-.127	1.0	
PHERB	-.806	-.103	.053	1.0
	PSURF	PSOIL	PCANO	PHERB

The set of independent variables, to be included in the canonical correlations are those variables in the factor analysis loading .3 or greater or -.3 or greater on the factors for which one or more of the four dependent variables also loaded .3 or greater or -.3 or greater. Correlations between variables in the independent set of variables were also checked for collinearity and multi-collinearity. Selected variables are not included in the canonical correlation and subsequent multiple regression. PMARMM and PMARF, for example are colinear; PMARMF is excluded from analysis because it is colinear with other variables. ALso, PWHITE and PBLACK are colinear and PWHITE is colinear with other variables. PBLACK is retained, but other multicollinear variables are dropped, including PMANG, PSERV, POPRT and PPOV. PUNDER5 is excluded because of colinearity with P5T17, PBLACK and certain socioeconomic variables. MAGE is excluded because of collinearity with P65OVER and other variables.

The analysis produces three canonical variates. Only two of the three variates pass the test of significance at the .01 level (see Table 4.5). With all three canonical correlations included, F=5.52, p 0.0. With the first canonical variate pair removed F remains significant, F = 2.98, p 0. With the first and second removed F=1.72 and p=.024. Since the third canonical variate is not significant it is not included in subsequent analysis or explanation.

TABLE 4.5

SIGNIFICANCE TESTS OF CANONICAL VARIATES

Variates Included	Wilkes Lambda	F	Hypoth d.f.	Error d.f.	Significants of F
1 to 3	.110	5.52	84	425	0.0
2 to 3	.409	2.98	54	286	0.0
3 to 3	.763	1.72	26	144	0.024

TABLE 4.6

EIGENVALUES AND CANONICAL CORRELATIONS

Canocical Variates	Eigenvalue	Canonical Correlation	Square Correlation
1st	2.72	.855	.731
2nd	.86	.680	.463

The first canonical correlation is .85, representing about 73.1 percent of the overlapping variance between the first pair of canonical variates. The second accounts for 46.3 percent of the variance between the second pair of canonical variates. Tabachnich and Fidell (1982, p. 158) recommend .3 as a cutoff for purposes of interpreting canonical variates, even if the pair of variates has passed the significance test. Clearly, the both canonical variates are worthy of further examination.

The first canonical variate extracts 33.6 percent of the variance from its set of dependent variables and the second 34.8 percent (Table 4.6). The redundancy coefficient (see Table 4.5) is a general measure of the extent to which each canonical variate of independent variables extracts variance from the opposing dependent variables. Redundancy is a useful coefficient to examine because, "It is possible, for instance, for a canonical variate from the IVs (independent variables) to be an important dimension in its own set of variables, but corelated with an unimportant dimension among the DVs (dependent variables) (and vice versa) (Tabachnick and Fidell, 1982). Examination of the two sets of redundancies coefficients in Tables 4.7 and Tables 4.8 reveals that the canonical variates reduce 40.66 of the uncertainty in the dependent variables, but only 21.2 percent of the uncertainty in the independent variables. The two pairs of canonical variates are more efficient in accounting for the set of dependent variables than accounting for the set of independent variables.

The only dependent variable relevent to the first canonical variate is PHERB, percent census tract covered by grass and other ground cover (Table 4.9). PCANO loads on the second canonical variate with a negative correlation. Thus, the second variate measures absence of canopy. Examining the correlation with the set of independent variables, the first canonical variate measuring grassy neighborhoods is related to a number of demographic and housing variables (see Table 4.8). Neighborhoods having extensive herbaceous ground cover tend to house married men, persons employed in precision work, people with higher rather than lower incomes and people who drive to work, rather than use public transportation. Also, roomy single family housing predominates, houses which are vacant tend to be for sale or occasional use, rather than for rent. Parks are in evidence and relatively few apartments are located in grassy neighborhoods. Also, the census tracts tend to be large, suggesting that the first canonical correlate applies to census tracts outside of the inner-city, where census tracts are small.

The second canonical variate is a negative indicator of tree canopy. Hence, variables having high negative correlations are related to the urban forest. A high median house value, and a high proportion of roomy single family housing is found in densely canopied neighborhoods. Also, rented housing found in those neighborhoods tends to be more expensive than other areas. Using a car for commuting to work and high proportions of married males are also related to tree canopy. The absence of industrial land uses describes neighborhoods with a dense tree canopy. The grassy neighborhoods (the first variate) and the well

TABLE 4.7

VARIANCE EXPLAINED AND REDUNDANCY ON CANONICAL VARIATES OF DEPENDENT VARIABLES

Canonical Variate	Variance Explained of Dependent Variables	Cumulative Variance Explained	Redundancy	Cumulative Redundancy
1st	33.6	33.6	24.5	24.5
2nd	34.8	68.4	16.1	40.6

TABLE 4.8

VARIANCE EXPLAINED AND REDUNDANCY ON CANONICAL VARIATES OF INDEPENDENT VARIABLES

Canonical Variate	Variance Explained of the Independent Variables	Cumulative Variance Explained	Redundancy	Cumulative Redundancy
1st	7.6.	7.6	10.4	10.4
2nd	5.0	12.6	10.8	21.2

TABLE 4.9

CORRELATIONS (LOADINGS) BETWEEN DEPENDENT VARIABLES AND CANONICAL VARIATES

Variable	Canonical Variates	
	1	2
PSOIL	-095	.164
PHERB	.957	.296
PCANO	.288	-.931

TABLE 4.10

CORRELATIONS (LOADINGS) BETWEEN INDEPENDENT VARIABLES AND CANONICAL VARIATES

Variable	Cannonical Variates	
	1	2
MRENT	.37	-.57
MEDINC	.49	.56
MVALUE	.22	-.48
MROOM	.37	-.54
CTAREA	.58	.33
PRENTHU	-.44	.34
PMRES	-.09	.04
PPARK	.49	-.10
PINDU	-.16	.54
PINST	.22	.12
PHU1	.34	-.34
PVACSALE	.38	-.15
PVACUSE	.43	-.20
PMARM	.43	-.47
P5T17	.08	.13
P18T64	.05	-.21
P65OVER	-.19	-.14
PSTBORN	.17	-.33
PBLACK	-.28	.38
PSPANH	-.03	-.26
PTECH	.05	-.40
PFARM	-.04	.18
PPREC	.41	.05
PPTRN	-.48	.29
PAUTO	.42	-.37
PPOOL	.28	-.10
PWALK	-.18	.19
MTTIME	-.12	.15

forested neighborhoods (the second variate) both apply to parts of the city characterized by relatively high socioeconomic status residents. However, an inspection of the loadings of variables related to wealth, such as median income, median house value, and median rent, suggest that wealth is more a hallmark of well-forested neighborhoods than grassy neighborhoods. Grassy neighborhoods are related to the presence of persons employed in skilled blue-collar trades and marginally related to vacant housing for sale or for occasional use. Forested neighborhoods tend to have residents who are not black and who were born in the state of Louisiana. Both grassy and forested neighborhoods are areas with relatively more married people, but age is not relevant. Although both grassy neighborhoods and forested neighborhoods share some characteristics in common, the patterns of the loadings suggest that the forested neighborhoods are older elite sections of New Orleans and the grassy neighborhoods are more suburban, more auto oriented neighborhoods and more blue collar. Neither densely-canopied neighborhoods or grassy neighborhoods are black or poor, suggesting that the benefits of urban greenery are differentially distributed among residents.

Significantly, the grassy neighborhoods and the forested neighborhoods in New Orleans are often not the same neighborhoods, as indicated by the loadings of the dependent variables on the canonical variates and an inspection of the maps of cover type. (See Figures 4.1, 4.2, and 4.3). Only eight census tracts exhibit more than 20 percent canopy cover and more than 20 percent herbaceous cover. All the eight exceptional census tracts can be explained by the presence of a large park, golfcourse, a park-like religious institution, or relatively large tracts of undeveloped land with trees and grass. Thus, the three category classification scheme of 1) grassy neighborhods, 2) forested neighborhoods, and 3) densely developed neighborhoods with little vegetation, holds up to close scrutiny. In this respect, New Orleans may differ from other cities in the United States, where trees and grass probably covary. If other American cities exhibit a cover geography of two zones, an inner-city zone of artificial surface with little canopy and little grass and an outer-city with more canopy and grass and less artificial surface, New Orleans seems to have at least three zones. One zone of dense canopy, less grass and moderate artificial surface coverage, a second zone of more grass and less canopy than the first, and a third zone of artificial surface and little grass and canopy. The first zone is scattered in Uptown, near City Park and near Algiers. The second zone, more suburban in character, is concentrated in the Lakefront and New Orleans East. The third zone of dense buildings and streets is concentrated in the CBD, French Quarter and Downtown.

In order to focus more closely on the urban forest component of land cover, two regressions were performed, using PCANO as the dependent variable and several independent variables identified in the canonical correlation. In the stepwise regression (see Table 4.11), tree canopy density can be explained by the median income of the census tract, the higher median income the greater the density of tree canopy, and by the percentage of land in industrial use, which is negatively related to tree canopy density. In the setwise regression only industrial land use is significantly related to tree canopy density, suggesting that colinearity is still a problem among the independent variables (Belsley, Kuh and Welsh, 1980). This is not unexpected because many of the independent variables can be theoretically related to a socioeconomic dimension. Neither regression explains an impressive percentage of the variance. Also, the standard error of the regression is similar for both regressions, indicating that predicted values of PCANO differ from actual PCANO by about 9 and one half percent of census tract land area (Achen, 1982 p. 62).

The burden of the evidence revealed in the statistical analysis indicates that the distribution of the urban forest in New Orleans is related to the socioeconomic status of neighborhoods and to neighborhood land uses. Industrial land is particularly inimical to urban trees. Inspection of industrial sites reveals few trees on the site. Newly-developed and spacious industrial land in New Orlean East is an exception because industrial land there tends to conform to the "industrial park" concept, allowing for trees and grasses. The positive relationship between a neighborhood's socioeconomic status, especially median income, and urban forest density is revealed in almost every analysis. The fact that the urban forest in New Orleans is spatially distributed in conformance with income is not in dispute. However, the above analysis fails to address the issue of causality. Do higher income persons select housing and neighborhoods because of the presence of a dense tree canopy or do higher income persons select housing and then plant trees? Most likely, both processes are operating in New Orleans. Certainly, the recent history of reclaimed land along the lakefront suggests that housing built for middle-income homeowners includes space for herbaceous ground cover and trees. Trees have been planted and in time tree canopy will cover an increasingly higher percentage of the land, growing over land that is now classified as herbaceous and artificial surface. Higher income persons also live in more spacious housing, as evidenced by a correlation of median income and median number of rooms of .735. More space means greater opportunity for increasing the tree canopy. Lower income households consume less space and have less space for planting trees. Evidence also supports the contention that

TABLE 4.11

THE EFFECTS OF CENSUS TRACT CHARACTERISTICS ON PERCENTAGE OF LAND COVERED BY TREE CANOPY

Variables	Stepwise Regression	OLS (Setwise) Regression
	b	b
MEDINC	.72**	.03
MVALUE		.02
MRENT		.12
PTECH		.05
PSTBORN		.09
PMARM		.15
PAUTO		-.03
MROOM		3.29
PRENTHU		.11
PINDU	-.17**	-.17**
PHU1		-.13
Intercept	8.82	4.89
Multiple r	.54	.59
Multiple r^2	.29	.34
Standard error	9.50	9.42
n	173	173

* Significant at .05 level, only.
** Significant at .01 level.

higher income persons select housing in areas with a relatively dense tree canopy. For example, areas of Uptown with some of the higher densities of tree canopy in the city and relatively old housing remain high and middle-income enclaves. Since persons with higher than average incomes can select roomier housing and more spacious and greener neighborhoods than lower income persons, the esthetic and environmental benefits of the urban forest are differentially distributed among New Orleans's citizens. Since publicly-owned trees are a "public good," like good streets, drainage, street-lights and other urban goods and services, the benefits of the urban forest are unequally shared.

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CHAPTER 5

URBAN FORESTRY MANAGEMENT AND PLANNING

The urban forest in New Orleans is a dynamic resource. Taken as a whole, the resource is in flux as new trees are added to the stock and other trees are removed from the stock. Meanwhile, trees remaining in the stock from year to year require maintenance. Thus, the urban forest resource during a given period of time consists of inflow, stock, and outflow.

Management of the urban forest resource requires intervention at three points: first, control over the location and selection of new trees added to the stock (inflow); secondly, maintenance of existing stock; and thirdly, control over trees removed from the stock (outflow). The first stage is particularly important because trees suitable to conditions in New Orleans should be selected in order to minimize problems of maintenance and removal. The last stage, removal of trees from the resource is also important because of the need to protect the public from deteriorating or falling trees and to insure that healthy or useful trees are not removed. The middle stage, or maintenance, is the most difficult because, as the inventory suggests, the New Orleans forest is a mature forest. Certain species, such as much-prized old live oak trees, require care. Also, trees in certain locations, such as along well-traveled avenues, may also require special care.

Trees in New Orleans are subject to a number of stresses, which should be considered in any tree management plan. These stresses can be given the general term "urbanitis". For example, polluted air stunts growth and adds to the tree's susceptibility to various diseases and insect infestations. Trees located along well-traveled avenues or near expressways are particularly at risk with regard to this aspect of urbanitis.

Another important manifestation of urbanitis is soil compaction, which usually occurs during construction when heavy equipment is operated near trees or when pavement such as driveways or sidewalks are built near a tree. Often no visual decline in the tree's health appears for several years after the disturbance, but eventually the tree's vigor is retarded and the once attractive canopy declines. The decline of a favorite shade tree can often be traced back to a walkway or drive installed five or ten years in the past. Thus, the general public is not often aware of the cause and effect of tree decline. In New Orleans street trees are

particularity susceptible to urbanitis due to the restricted areas in which species requiring more than average growing space are located and due to heavy pedestrian traffic. Live Oaks, which require substantial space for root growth, are often found along streets and on median stips (neutral grounds). In addition, much of the main root system grows above ground and is therefore impacted by heavy pedestrian use or other damage.

Another root problem which effects trees in almost all locations in New Orleans is the high water table, which causes trees to have extremely shallow root structures. This make trees susceptible to droughts and a declining water table. Also, the trees are relatively easy to uproot. Massive old live oak trees have been uprooted as a result of traffic acidents. Land subsidence is another problem in New Orleans which can damage tree roots.

Planting trees which are not totally suited to the New Orleans climate is another problem. While outside the realm of urbanitis, it is nonetheless a serious problem in New Orleans. The growing season, or the number of days between the average last 32 ^{o}F freeze in the the Spring and the first freeze in the Fall, is about 310 days in New Orleans (Cry, n.d.). Thus, the probability of a winter freeze is great. At the same time residents of the city have exhibited strong preferences for tropical vegetation over the years. Many species may not be well-suited to New Orleans. Experts agree that various species of palms and Golden Raintrees are at risk. While microclimates protect some trees, freezes periodically kill many tropical plants. A severe freeze during the winter of 1983-84 caused the loss of 1,111 trees and 1,623 shrubs on city owned property (Parkway and Park Commission, n.d.). Replacement of the dead trees and shrubs is estimated to cost $182,048.91 (Parkway and Park Commission, n.d.). Damage caused by freezes during the winter of 1984-85 have not been reported at the time of writing.

In summary, the urban forest of New Orleans is subject to typical urban stresses found in any city (urbanitis), as well as stresses specific to New Orleans and its vegetation, such as freezes and a high water table. These facts, together with the realization that the New Orleans urban forest is mature, suggests the need for considerable maintenance and care in order to preserve this valuable resource.

INSTITUTIONAL ACTORS

Several public and private agencies are responsible for the management of urban vegetation in Orleans Parish. At the state level the Louisiana State Forestry Commission includes an urban forester whose primary function is to assist urban managers in developing urban forestry programs and maintaining urban vegetation as an environment-enhancing resource. The urban forester, Paul Orr, has assisted City Park in its partial inventory of Live Oaks and Audubon Park in a similar effort. Since Orr serves the entire state, only a portion of his time and expertise is available to managers of the urban forest in New Orleans.

A second state agency, the Louisiana State University Cooperative Extension Service, provides assistence for private and public owners of urban vegetation. Dr. Severn Doughty and Dan Gill provide advice on tree selection and care, in addition to the provisions of advice on urban vegetation in general. The extension service is active in public education, especially in publishing brochures on tree care, tree values and tree selection (Pope, n.d.; Main, Pope, and Mills, n.d.; Main and Cassens, n.d.; Louisiana Cooperative Extension, 1985; Doughty, 1980). According to Doughty the most frequently asked question about trees is, "What is the fastest growing shade tree?" Also, the public is now aware of the risk of frost damage to vegetation and is now selecting tree species accordingly.

The Parkway and Park Commission is responsible for planning and maintaining the publically-owned urban forest resource in the City of New Orleans. The Commission is responsible for trees between sidewalks and streets and all median strips (neutral grounds). In addition, the Parkway and Park Commission is responsible for parks, except City Park (which is a state park) and Audubon Park (which is administered by a seperate commission). Also, the commision maintains New Orleans Recreation Department playgrounds, but does not plan them.

The Parkway and Park Commission, under the direction of Florence Schornstein, consists of a number of divisions, including Maintenance, Planning and Design, and Forestry. Maintenance is responsible for the maintenance of shrubs and grass, rather than tree maintenance. Planning and Design, headed by John deBessonet,who is a registered landscape architect,plants and maintains shrubs on the median strips (neutral grounds) and is responsible for assisting citizens who plant trees on public property between the street and the sidewalk. Also, the division approves the landscape site plans for buildings and sub-divisions proposed by residential developers. The Planning and Design

Division encourages the selection of species which are likely to survive the colder winters and drier summers which New Orleans has recently experienced. For example, the division does not encourage the planting of Washingtonia palms or Golden Raintrees. Mr. deBessonet expresssed a preference for crape myrtles, small leaf elms, dogwoods and other flowering trees. Other species recommended are found in the tree rating guide (which is explained below).

A nursery is located on the grounds of the Parkway and Park Commission for stocking purposes. Once a year the nursery is open to the public for puchasing seedlings. Sales totaled about 1500 trees in 1984. The public is encouraged to purchase trees which are native to the area or suitable to the environmnet. In addition to tree planting by individuals, the division also works with neighborhood groups wishing to plant trees along a street. The division counsels neighborhood groups on the selection of appropriate trees after conducting a site review.

Funding for tree planting comes from public and private sources. Public funding for stocking puchases does not appear as a line item in the budget of the Parkways and Park Commission and normally tree planting is not funded by the city's capital budget. However, the City Council voted $100,000 for replacement of trees and shrubs killed in recent freezes. A trust fund, the "Plant A Tree Fund," supports the tree planting and nursery program. Private funds are donated to the trust for the purchase of new trees.

The Planning and Design Division of the Parkway and Park Commission works with the New Orleans City Planning Department on the Planning Advisory Committee, in planning and approving parks facilites designs, major construction designs, and site plans for proposed private developments and subdivisions which include tree and shrub plantings. Recently, the division has been engaged in planning a new nature park at English Turn on the Lower Coast of Algiers and redesigning other existing parks. The Parkway and Park Commission ranks the importance of projects and submits the project in the form of a five year plan (Parkway and Park Commission, n.d.) to the City Planning Department and ultimately City Council for funding.

Problems in managing the design and planting of the urban forest were identified by John E. DeBessonet, the landscape architect in charge of the section. DeBessonnet stressed a need for a computerized inventory of all city trees, recognition of soil conditions in the city, a lack of funds to maintain the existing forest, and better education of the public when choosing trees for plantings.

The Forestry section, headed by Larry Christian, a registered forester, completes the commission's role. The Forestry section's responsibilities are the removal of undesirable trees and limbs and maintenance of the existing urban forest on public property. Most work is completed by Forestry unit personnel, although a private contractor completed some work during 1984. Trees and median strips (neutral grounds) requiring work are brought to the section's attention by letters and phone calls from the general public, as well as city agencies. In 1984 the section received 3,228 letters. The Forestry Unit and its contractor completed the following projects in 1984 (Parkway and Park Commission, n.d.b.):

Trees trimmed	7326
Trees removed	2668
Log truck pick-ups	3048
Root Assistance	90
Stumps ground out	2048
Stop signs cleared	86
Emergencies (not detailed)	864

Work orders which were issued totaled 3,359 and 3,257 were completed, with the remaining orders carried into 1985 (Parkway and Park Commission, n.d.) As can be seen, a considerable amount of the work of the Forestry unit consists of tree removal, tree pick-up, and unspecified emergencies. Mr. Christian admits that since most of the effort of the unit is given over to tree removal, few resources are devoted to tree care and maintenance.

The section coordinates with the Planning and Design section when cases appear before the Tree Appeal Committee, which rules on citizen requests for tree removal. When a case reaches the Tree Appeal Committee a forester conducts a review of the condition of the tree in question. Permission to remove a tree is most often denied if the tree is healthy. A citizen who is not satisfied can appeal again and then appeal a second time to the entire Parkway and Park Commission. Property owners can be and have been fined if they remove or damage a publicly-owned tree. The Forestry section maintains a working relationship with New Orleans Public Services Incorporated (NOPSI), the public utility company in New Orleans, and consults with their line maintenance crews when hazardous trees are located near of high voltage lines. NOPSI trims all trees which in their judgement interfere with power lines and other services.

Christian's perception of the urban forest is that it is "over-mature" and will soon be experiencing a high mortality rate due to aging and the possible threats of

disease. Christian and DeBessonet both stressed the unusual environment and soil conditions in New Orleans. Consequently, tree diseases and mortality rates are difficult to measure when compared to other parts of the country.

The New Orleans Planning Commission is peripherally involved in urban forestry issues. In its bi-yearly Citizen's Attitude Survey, the commission queries residents as to their satisfaction with the frequency of tree trimming, enforcement of litter control, the number of small parks with trees and leisure spots, and frequency of grass cutting in vacant lots. The City Planning Commission also approves development and sub-division plans. When the plans include tree planting or other landscaping, the commission refers the plans to the Planning and Design Department of the Parkway and Park Commission for approval.

The New Orleans Levee Board maintains vegetation on Levee Board land along Lake Ponchartrain. Warren Star, the Superintendent of the Field Office, is responsible for tree selection and planting, tree care, and tree removal. Two other commissions exercise control over portions of the urban forest. Each manages one of the two large parks in New Orleans. Audubon Park and Zoological Gardens, located in the Uptown section of New Orleans between the Mississippi River and St. Charles Avenue, is administered by the Audubon Park Commission. Funding comes from the city government and the "Friends of the Zoo." Ann Flowers, the Grounds Manager in charge of all vegetation in the park, reports to the Green Committee of the Audubon Park Commission Board. With the exception of landscape architects hired to plan the Zoological Gardens, Flowers is responsible for the selection, care and removal of all trees in Audubon Park, including the golfcourse. Thus, the tree management is centralized in the park because Flowers controls tree planting, continued care, and removal. Flowers seeks advice when necessary from the state urban forester and the Louisiana Cooperative Extension Service. City Park, located between Mid-City and the Lakefront sections of New Orleans is administered by the City Park Commission. A citizens group called the Friends of City Park provides financial assistance and volunteers.

CONCLUSIONS AND RECOMMENDATIONS

Urbanitis and other problems cannot be totally prevented, but planting species of trees which are able to withstand urban stresses and which are appropriate to their location will help prevent many problems of a deteriorating publicly-owned and privately-owned forest resource. This can only be accomplished if (1) the general public

is educated in tree selection and (2) agencies responsible for the publicly owned portion of the urban forest coordinate the selection, planting, and maintenance of the urban forest.

A serious effort to educate the general public is underway. Several experts on urban vegetation perceive that the New Orleans public continues to hold preferences for tropical plants which are not really suited to the New Orleans climate due to winter freezes. The severe freezes of the last two winters have done much to educate the public, which is gradually becoming more realistic in selecting trees and shrubs. The Louisiana State University Cooperative Extension Service through articles in the local newspaper, brochures, telephone advice and talks to community groups attemps to educate the public about freeze damage and tree selection. The Planning and Design Unit and Forestry Unit of the Parkway and Park Commission also attempt to educate individuals at their annual tree sales. The Planning and Design Unit also attempts to guide tree selection of neighborhood groups seeking assistance. The most frequently cited vehicle for public education is the brochure Trees for Louisiana Landscapes: A Handbook (Louisiana Cooperative Extension Service, n.d.) and its Supplement Rating Trees for the New Orleans Area: A Supplement to "Trees for Louisiana Landscapes," (Louisiana Cooperative Service, 1985). The supplement rates trees according to their suitablity in New Orleans. The supplement was originally compiled by the Metropolitan Area Horticultural Advisory Committee, a group of horticultural experts. The brochure was recently revised to reflect knowledge gained during the freezes of the winters of 1983-84 and 1984-85.

The exchange of information between local experts and private landscaping firms and retailers of trees takes place within the context of the Metropolitan Horticultural Advisory Committee and less formal contacts. The impact of these contacts on commercial retailers of trees is difficult to assess. If the public is able to continue to indulge its tropical fantasies by selecting certain species of palm trees and other trees which are not appropriate to New Orleans, the freezing, browning, and death of portions of the urban forest will continue. Doughty claims that during the last ten years he has been professionally active in the New Orleans area he has noticed marked improvement in the tree species sold by retailers of trees. However, many retailers continue to sell unrecommended species because consumers ask for them and purchase them even when warned of their unsuitability. Thus, it appears that public

Figure 5.1:
Freeze-damaged
palm on the
"neutral ground" of
Chef Menteur Highway.

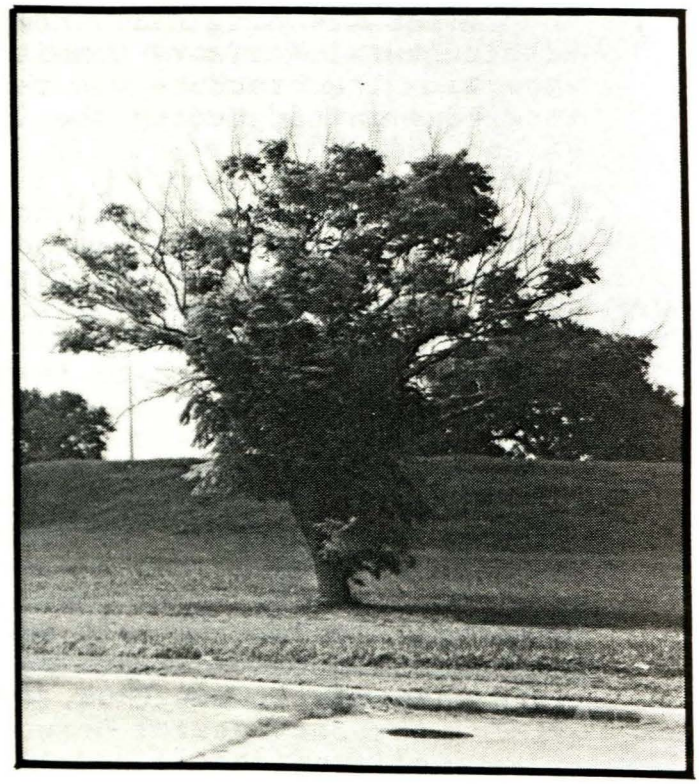

Figure 5.2
Freeze-damaged
Golden Raintree
near Bayou St. John
Levee.

education, rather than pressuring commercial nurseries, is the most efficacious strategy to encourage the selection and planting of appropriate tree species.

Secondly, the successful management of the publicly-owned portion of the urban forest depends upon coordination among various commissions and agencies. As explained above, intervention can occur at the point of input into the forest resource (tree selection and planting), maintenance, and at the point of outflow from the resource (tree removal). For trees located along streets and medians (neutral grounds) the Parkway and Park Commission is involved in all three phases.

Tree removal is effectively controlled and policed by the Tree Appeals Committee and the Forestry division. However, the Forestry division is forced to expend a considerable portion of its manpower, time and money on tree removal to the detriment of tree maintenance. This is recognized as a problem by the division, but the need to protect the public from the hazards of dead or declining trees and the need to protect the city from liability suits together with an inadequate budget, make the present allocation of resources the only immediate solution. An increased Parkway and Parks budget is a preferred solution, however.

Another management issue requiring attention is the coordination between selection and planting, as an input into the forest resource, and continued maintenance of the trees. The Planning and Design division of the Parkway and Park Commission is staffed by landscape architects and the Forestry division by foresters. While both groups share the goal of creating a liveable urban environment, professional emphases differ. The Forestry division emphasizes the selection of long-lived hardy species, planted at an appropriate distance from other trees; the Planning and Design division is ready to sacrifice tree longevity for esthetic affect and the satifaction of the public's preference for flowering trees. Since the Forestry division has the task of maintaining trees promoted and selected by the Planning and Design division, close coordination in tree selection should be a goal. This lack of coordination has not been a major problem so far because the Forestry Division, of necessity, devotes little effort to tree maintenance. However, if a budget increase allows for more maintanence on more recently planted trees, coordination will become an important issue.

Coordination on a larger scale also appears to be needed. Audubon Park, City Park, and Levee Board trees are managed separately from other publicly-owned trees. Managers in Audubon Park, City Park and Parkway and Park Commission consult, with one another and consult separately

with the Louisiana Cooperative Extension Service and state forester about common problems and techniques. Information is shared informally. In fact, the provision of information appears to depend to a high degree on personal relationships and contacts. This style does not present a problem as long as all forestry mangers are included and none are excluded for personal or professional reasons. New managers and experts should be quickly assimilated into the group.

A second issue connected with the informal exchange of information is the observation that a large portion of the information is concerned with very specific problems or techniques. For example a manager may seek assistance from a colleague on the condition of a single tree. It does not appear, however, that the provision of piecemeal information which takes place is automatically translated into an overall picture or plan for the urban forest in New Orleans. While managers in various agencies and commissions are each concerned with their own portion of the urban forest, no single manager or body is considering the entire urban forest resource. A Metropolitan Area Horticultural Advisory Committee consisting of representatives of some of the above-mentioned bodies, together with a number of commercial nurseries, is the only consortium of experts in the New Orleans area. The urban forest, however, is not the only concern, or the principal concern of the committee. In addition to the compiliation of a rating guide for trees, the committee organized a rating guide for shrubs and ground covers and organized an exhibit of native plants for the Louisiana World Exposition of 1984. Thus, the role of the committee is not limited to urban forestry issues. The need remains for a body to plan for the entire urban forest and coordinate its management. Perhaps the need does not appear to be urgent to urban vegetation managers who manage portions of the forest resource. Reasons for a coordinated approach to planning and management can be succinctly stated.

First, boundaries between different tree management jurisdictions are permeable. Diffusion and spread-effects between jurisdictions occur. Examples include a spreading disease, volunteer plants, or even the spread of human use from one zone to another. The diffusion of a disease is one eventuality that would demand planning and management coordination. Fortunately, New Orleans has not experienced a devastating disease similar to Dutch Elm Disease, which caused extensive defoliation in cities in other regions of the United States. However, a threat to the city's live oaks is on the horizon in the form of oak wilt (USDA Forest Service, 1983).

Secondly, research projects sponsored by the U.S. Forest Service and other research project demonstrate that trees effect many other components of urban life. Trees

improve air quality (Smith and Dochinger, 1975), ameliorate noise pollution (Cook and Van Havenbeke, 1971), improve micro-climates (Herrington, 1978), benefit water control and run-off (Ripley and Ellersten, 1971) provide wildlife habitats (Franklin, 1982), provide psychological benefits to people and enhance the quality of life (Driver, Rosenthal and Peterson, 1978), increase land values (Bickley, 1978; Kielbaso, 1971), as well as offer obvious esthetic benefits (Nelson, 1975). If urban managers should attempt to intervene in any of these phenomena or problems, the contribution of the urban forest to solution of the problem can be maximized by managing the forest as a whole, rather than in piecemeal fashion. Methods for integrating urban forest management into city planning for the enhancement of quality of life goals are now being developed (Sanders, 1984).

Thirdly, in a city where tourism is so crucial to the local economy, the trees and vegetation in the city are an important part of the image of New Orleans. One recent guidebook gives a poetic account of the importance of vegetation to the city's image.

> New Orleans, like any other place that persists in the mind's eye, has its own distinctive collection of shapes and forms which stop the eye and create scale; these are combined in an infinite number of permutations to form the particular image of New Orleans. The shapes and forms relate..., particularly to the subtropical plant forms which line and furnish yards and streets. The live oak, the banana tree, the palmetto, the magnolia, and a host of other trees and plants enclose, cover, define, direct and extend space in a thousand ways. They play with light in a complexity of patterns no architect could design (The New Orleans Chapter of the American Institute of Architects, 1974).

In conclusion, information presented in this report demonstrates that the collectivity of trees in New Orleans constitutes a genuine forest. In the developed portion of New Orleans, 21.24 percent of the land is covered by tree canopy, a considerable resource, indeed. The urban forest reaches into virtually every district and neighborhood of New Orleans. A resource which is so ubiquitous and so important to the people of New Orleans, deserves careful, coordinated management.

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APPENDIX

Ailanthus	Ailanthus altissima
Arizona Ash	Fraxinus berlandieriana
Green Ash	Fraxinus pennsylvanica
White Ash	Fraxinus americana
Red Bay	Persea borbonia
River birch	Betula nigra
Boxelder	Acer negundo
Red Bud	Ceris canadensis
(Southern) Catalpa	Catalpa bignonioides
Camphor-tree	Cinnamonnum camphora
Black Cherry	Prunus serotina
Cherry Laurel	Prunus caroliniana
Chinaberry	Melia azedarach
(Kentucky) Coffeetree	Gymnocladus dioicus
Eastern Cottonwood	Populus deltoides
Crape Myrtle	Lagerstroemia indica
Bald Cypress	Taxodium distichum
Pine Cypress	Taxodium distichum var.nutans
Dogwood	Cornus florida
American Elder	Sambucus canadensis
American Elm	Ulmus americana
Small Leaf Elm (Chinese Elm)	Ulmus parviflora
Ginkgo	Ginkgo biloba
Golden Raintree	Koelreuteria formosana
Hackberry (Sugarberry)	Celtis laevigata
Hercules Club	Zanthoxylum clava-herculis
American Holly	Ilex opaca
Possumhaw Holly	Ilex decidua
Hornbean	Carpinus caroliniana
Pyramid Magnolia	Magnolia pyramidata
Southern Magnolia	Magnolia grandiflora
Sweetbay Magnolia	Magnolia virginiana
Red Maple	Acer rubrum
Silver Maple	Acer saccharinum
Sugar Maple	Acer sacharum
Mimosa	Albizzia julibrissin
Bluejack Oak	Quercus incana
Cherrybark Oak	Quercus pagoda
Laurel Oak	Quercus laurifolia
Live Oak	Quercus virginiana
Overcup Oak	Quercus lyrata
Water Oak	Quercus nigra
White Oak	Quercus alba
Willow Oak	Quercus phellos
Parkinsonia (Jerusaleum Thorn)	Parkinsonia aculeata
Pecan	Carya illinoensis
Persimmon	Diospyros virginiana
Podocarp	Podocarpus macrophyllus
Cabbage Palmetto Palm	Sabal palmetto
Loblolly Pine	Pinus taeda
Slash Pine	Pinus elliottii

APPENDIX (continued)

Spruce Pine	Pinus glabra
Silverbell	Halesia diptera
Sweetgum	Liquidambar styraciflua
Sycamore	Platanus occidentalis
Tulip Popular	Liriodendron tulipifera
Tung Oil	Aleurites fordii
Black Willow	Salix nigra
Weeping Willow	Salix babylonica
Washingtonia Palm	Washingtonia filifera
Texas Palmetto	Sabal texana